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THE FRENCH ARMORCLAD NEPTUNE.

THE speed and gunnery trials of the new French armorclad ship Neptune have lately been commenced off Brest, where the ship has been built, having been laid down toward the end of the year 1880, and launched on the 7th of May, 1887.

The Neptune, says the *Marine Engineer*, is a sister ship to the armorclads Marceau, which lately visited Portsmouth with the French fleet; the Hoche, commissioned as flag ship of the second division of the Mediterranean Squadron; and the Magenta, now fitting out at the Toulon Arsenal, and which will be put into commission during the present year. Since, however, the original designs for the Neptune were made, great alterations have taken place in the armament and the upper works of the hull, until at the present time very little resemblance in general outline between the four sisters is apparent. In the Neptune the freeboard, forward and aft, has been kept lower than was originally designed, and for this reason she much more resembles the Hoche than either the Marceau or the Magenta.

The hull has been entirely constructed of iron from the keel up to the armor shelf, but above this level steel has been employed with the view of economizing weight.

Below are given the principal dimensions of the ship:

Length	330 ft.
Beam	65 ft. 7 in.
Depth	43 ft. 3 in.
Draught	27 ft. 3 in.
Displacement	10,600 French or 10,388 English tons.

The hull below the armored deck is extensively divided into watertight compartments by transverse and longitudinal bulkheads. An armored belt extends the entire length of the ship at the water line from stern to stem, where the abutment of the two forward plates gives great strength to the ram. This belt is formed of compound armor plates, having a thickness forward at the water line of 15¾ in., amidships of 17¾ in., and aft a thickness of 13¾ in. The armor of the four barbette towers is formed of plates 15¾ in. thick, while the armored deck, extending the whole length of the vessel above the armor belt, has a thickness of slightly over three inches. The men working the large guns are protected by a shield constructed of two-inch armor plate.

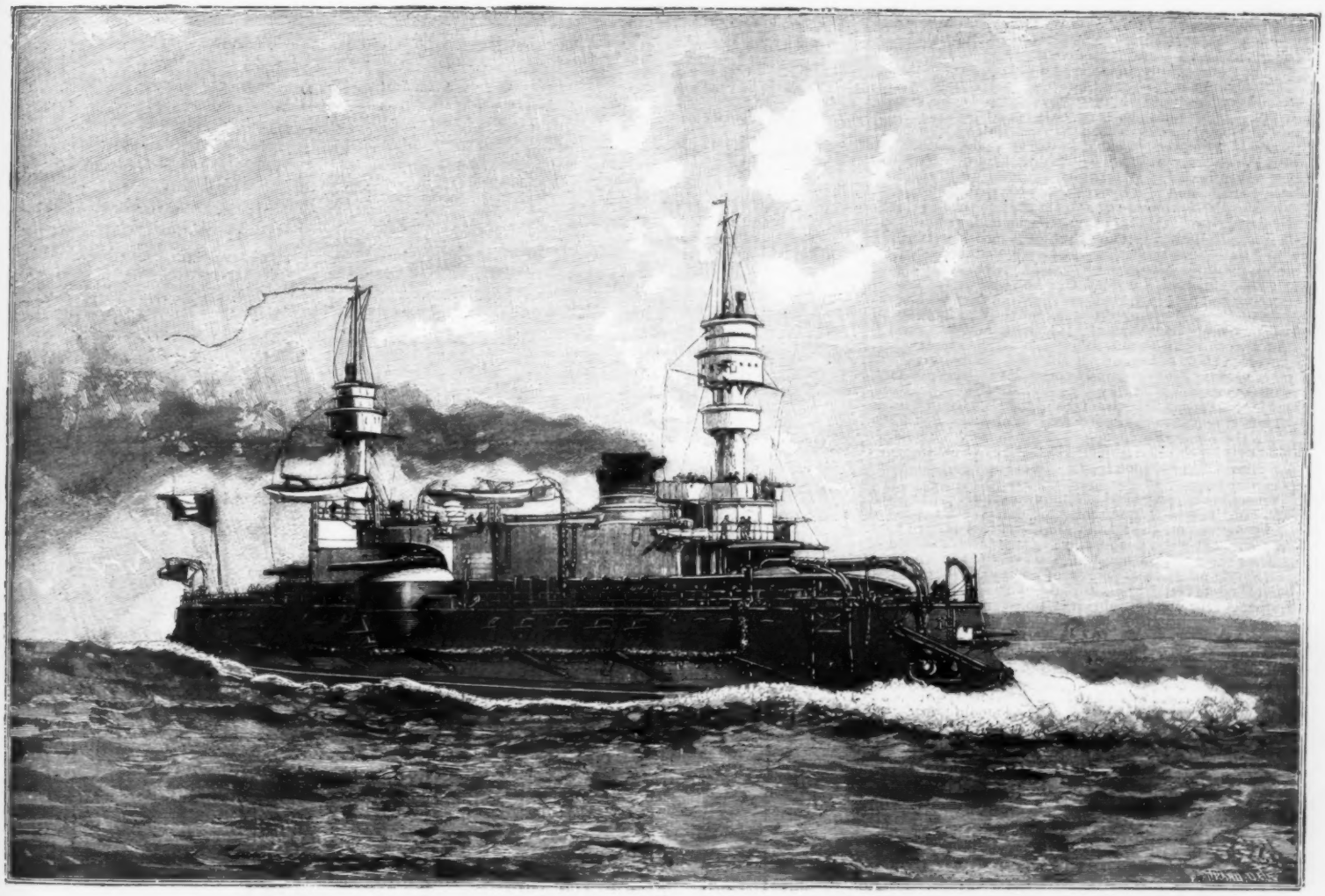
Two military masts, with a double top on each, have been supplied, and these are fitted interiorly with two ladders, one for ascending to and the other for descending from the tops. There is also a hoist for the ammunition for supplying the Hotchkiss guns situated in these tops.

The engines, four in number, are of the vertical, compound, two-cylinder type, two driving each of the two propellers, and developing a total I. H. P. of 7,000, from which H. P. a speed of about 15 knots per hour is expected. The engines have been built by the government at its engine works in Indret, and are so arranged that the two forward engines can be disconnected from the two after ones, and the ship driven by the latter two only; a considerable economy in fuel being thus obtained. Under forced draught, the Neptune will probably give sixteen knots, the H. P. being correspondingly increased. The boilers were likewise built by the government, and are constructed to work at a pressure of 85½ lb. per square inch. There is bunker capacity for carrying 600 tons of coal, which, at a speed of 10 knots per hour, should be sufficient to allow the ship to make a voyage of at least 4,000 knots.

As is usual in warships of the present day, the ship is lighted by the electric light, and is supplied with electric search light projectors.

With regard to armament, the Neptune compares well with other ships of her tonnage. It consists of four breech-loading rifled guns of 34 centimeters (13·385 in.) weighing 52 tons; sixteen 14 centimeter (0·551 in.) 2¼ ton B. L. R. guns in the battery, eight on each broadside, and four guns of the same caliber and weight in various positions above the upper deck. In addition to the above the ship is armed with a large number of Hotchkiss quick-firing and machine guns, some of these being mounted in the military tops, and lastly four torpedo-firing tubes for discharging Whitehead torpedoes by means of gunpowder. The positions of the four heavy guns are the same as in the Marceau and other sister ships, one forward, one aft, and one on a sponson amidships on each broadside. Three out of the four heavy guns can thus be brought to bear on an enemy in almost any position.

The estimated cost of the Neptune complete with her armament was about $3,900,000, but this has probably been somewhat exceeded, owing to the great alterations which have taken place in the original design.



THE NEW FRENCH ARMORED SHIP OF WAR NEPTUNE.

FAST FIRING WITH MACHINE GUNS.

MR. HIRAM S. MAXIM writes to *Engineering* as follows: Of late there has been going the rounds of the press, especially in America, an account of an automatic machine gun made by the Winchesters, which is said to fire "a thousand rounds a minute, and to beat the Maxim, because the Maxim only fires 750 a minute." In connection with this it might be interesting to the public to know just how fast it is possible to fire a single-barreled automatic gun, and what sort of cartridges can be fired with the greatest rapidity.

The first automatic Maxim gun which was submitted to an official test at Enfield was claimed to fire 600 rounds a minute, using the Royal Laboratory machine gun cartridge. At the trials 1,000 cartridges, all in one belt, were fired in one and a half minutes. This would give a speed of 666 rounds per minute. The Royal Woolwich cartridges, considered from all points, are perhaps the most perfect cartridges to be met with today. Of over 200,000 rounds which I myself have fired, I have only found one faulty cartridge, and this missed fire on account of not having any fulminating powder in the primer. At the official trials in Switzerland, where the German Mauser cartridge was used, the official speed was 612 per minute. At the Italian trials, which took place with the same cartridge at Spezia, the rate of fire was found to be 620 per minute. The French Gras cartridges, which had been made seven or eight years, were found to fire at the rate of about 500 per minute; those which were only two or three years old, at the rate of 600 a minute; while with those that had only been made a few weeks, the rate of fire amounted to nearly 700 per minute. At the Austrian trials with the old Mannlicher cartridge the rate of fire was 620 per minute. With the new Austrian cartridge

with compressed powder, a speed as high as 770 per minute was attained. With the Russian Berdan cartridge, made on the old fashioned plan, having a hollow rim, 1,000 rounds were fired out of a single belt in 2¼ minutes. This was the slowest of all European cartridges except those made in Italy for the old Vetterli rifle, which were found to be very imperfect, and the rate of fire in some cases did not exceed 300 per minute. In Spain, cartridges were found which were so bad that they could not be fired at all with an automatic gun. In Germany, the rate of fire varies according to the kind of cartridges which are employed, and ranges from 600 to 700 per minute. Of all the black powder cartridges, the American service cartridge has been found to attain the highest speed. This arises from the fact that the cartridge is small and short, the powder compressed, and the primers very large. At trials which took place in England with this cartridge the rate of fire was 742 per minute. At trials which took place in the United States, in which new cartridges made by the Union Metallic Cartridge Company were employed, the rate of fire was 775 per minute. This was the highest rate of fire ever attained by an automatic gun deriving all of its energy from the recoil. After the Maxim gun had been formally adopted into Her Majesty's service it was found necessary to provide some means of operating them with blank cartridges, as these of course did not give sufficient recoil to operate the mechanism. Attachments were then put on to guns which were required for the maneuvers, in which the escaping gases at the muzzle of the gun produced an action upon the barrel similar to that of recoil. The first of these guns was made for the Easter maneuvers some five years ago, and the first cartridges experimented with were loaded with 60 grains of black powder, the rest of the case being filled with tallow, but the rate of fire was so enormously high that the powder charge was reduced to 42 grains, and with this the rate of fire fell to about 600 per minute. About two years ago, while we were experimenting with the French Lebel cartridges in Paris, I had a gun constructed to utilize the force of the escaping gases at the muzzle for operating the mechanism. The number of cartridges which the officer brought to the trial was only 200; consequently only small belts were used. Upon placing a belt of twenty cartridges in the gun and pulling the trigger, I remarked, "The gun has stopped, it does not work," whereupon my French assistant pulled the belt out and said, "It is quite empty." My ear had been accustomed to a fire of about 600 per minute, and the usual belts that we first try a gun with hold only 10 cartridges. These twenty Lebel cartridges had gone off in just about the time that 10 English cartridges would have been fired. The speed was found to be somewhere between 1,100 and 1,200 rounds per minute, and the officer in charge decided that the rate of fire was altogether too high, expressing the wish that we should seek to reduce the rate of fire rather than to increase it. It is a curious fact that the German and the French committees, acting quite independently of each other, expressed their opinion that the most desirable rate of fire would be 250 per minute, and guns were, in fact, made for these two nations provided with regulators, but it was found that the mechanism necessary to reduce and regulate the speed of a gun was quite equal to all the rest of the mechanism in the arm. The first one-pounder Maxim guns fired at the rate of 400 shots per minute. The speed was afterward reduced to 300 per minute.

The effect of very rapid firing upon the chamber and rifling of the gun is most marked. In Austria, when a gun was fired at the rate of about 600 per minute with steel-covered bullets, and the fire was often stopped to replace the ammunition boxes, it was found that the gun made as good a target after 20,000 rounds had been fired as it did upon starting, while with a speed of 670 per minute with practically no stoppages, the bore was considerably injured after 10,000 rounds had been fired. During all of the Austrian trials with the Maxim gun, 200,000 rounds of ammunition were used, the greatest number fired at one time from a single gun being 35,000.

As regards the speed that it might be possible to attain with a single-barreled gun, I would say that probably if both the gun and cartridge were made expressly for producing the highest possible rate of fire, and if the recoil energy, together with the escaping force of the gases, were both utilized, 1,500 to 1,600 rounds a minute might be fired, but at this speed the barrel would be very highly heated, even if inclosed in a water casing.

Machine guns which are operated by hand are as a rule provided with more than one barrel, and perhaps the greatest absolute speed that ever has been attained was with a twelve-barrel Nordenfelt gun, in which each barrel was fired 100 rounds per minute, but this feat can only be accomplished by a very powerful and trained athlete. The Gatling ten-barrel gun did not, I believe, fire over 400 rounds a minute at the Shoeburyness trials, but it is said now to fire at the rate of 100 rounds per barrel per minute. The greatest speed ever attained by a single barrel hand-operated machine gun was when Gardner himself fired 250 rounds per minute. The Nordenfelt five-barrel gun, such as is used in the British navy, may be fired with three trained operators about 400 to 500 rounds per minute. At the Swiss trials the two-barrel Gardner gun, with four men to operate it, fired 333 rounds in a minute.

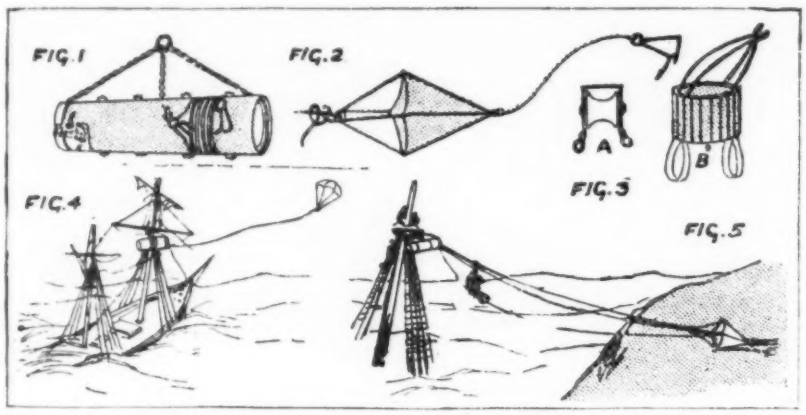
As far as guns of a larger caliber are concerned, perhaps the highest rate of fire ever attained with only one man loading and firing was in France, about three years ago, when I myself succeeded in firing 40 rounds in 50 seconds. The gun was a 3 pounder and the cartridges about 21 in. long.

LIFE SAVING DEVICES.*

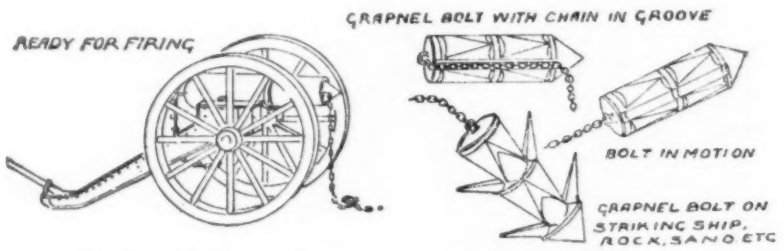
MR. J. WOOLVEN sends us a long description and several sketches of his apparatus for use from vessels when stranded near the shore. It consists of a canvas receptacle of round shape, tapering to the top, large enough to hold 300 yards of 3½ inch supple strong hemp rope and the same quantity of light (double) strong line to form an endless fall or whip, rove through a small swivel tail block, and about the same length of very small line attached to a large rope and whip line, with a swivel that can be detached when the large rope and whip are pulled ashore. This receptacle could be made fast to a mast or other holdfast. Attached to the top end of a light line would be a parachute of light canvas sewn to a light strong wooden hoop, with inflated skins or bladders fixed upon the inside. A lead ball suspended from it would keep it perpendicular and buoyant, and the light line would be made fast to the ball. The parachute would cover the top of the receptacle, and be tied with spun yarn, so as to be quickly cut adrift. When the ship grounded, the parachute could be cut adrift and sent ashore to be secured by the coastguards or others. "Cork belts would be carried for the crew and passengers, with canvas loops to pass legs through, and fixed to cords to suspend upon a spring or snatch hook fitted with sheave to run upon the large rope, with a short rope tail attached to hook or traveler for making fast to endless tail or whip by a rolling or other hitch for pulling ashore." The sketch shows in Fig. 1 the apparatus packed for hoisting into position; Fig. 2, the parachute, which may be used as a holdfast when ashore by filling it with stones; Fig. 3, traveler, A, with spring hook and cork belt, B, to hook on traveler; Fig. 4, drum hoisted under foretop and parachute blowing to shore; Fig. 5, mode of landing.

Mr. Fynmore's idea is to use a short gun or mortar, mounted on a carriage so as to be readily moved. The projectile would be the "grapnel bolt," shown in the drawing, which would carry a chain with it, and on striking ground would open up as indicated in the sketch. The chain would fit into a groove in the projectile and pass out at the mouth of the gun, and would be attached to a line of coir or other material which would float. Mr. Fynmore also sends us his idea for preventing vessels stranding. It consists of a triangular piece of plate iron or steel from one inch upward thick, according to the size of the ship. It would be attached to the inner keel, and can be lowered by a lever. The lowering bar, when the indicator is down, could be connected to a slight rod or other contrivance, so that when the indicator came in contact with the bottom it would be forced upward and cause a bell to ring, which would be heard all over the ship, while upon an index in the engine room and wheel house the finger would point to full speed astern.

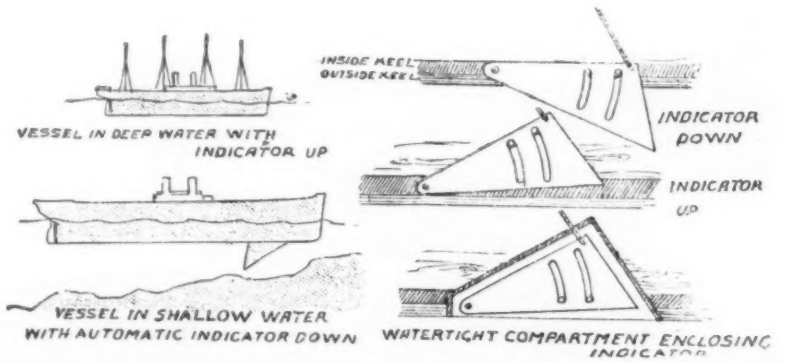
We illustrate a design by Mr. J. R. Jack, who sends a sketch of a buoy he has invented to carry a line ashore. He says it may be constructed of iron or copper of about 3 ft. diameter in its widest part, 1 ft. deep. Before it is dropped into the sea from the point of the ship nearest to the shore a double line of light strong rope should be attached through a roller pulley. When it is thrown by the waves as far on the beach as its depth and its grapnel will allow, a stronger line can be sent ashore. The cage at the top could contain



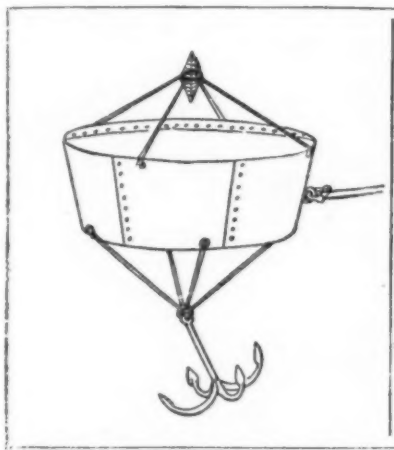
PARACHUTE APPARATUS TO CARRY CORD ASHORE. (From sketches by Mr. J. Woolven.)



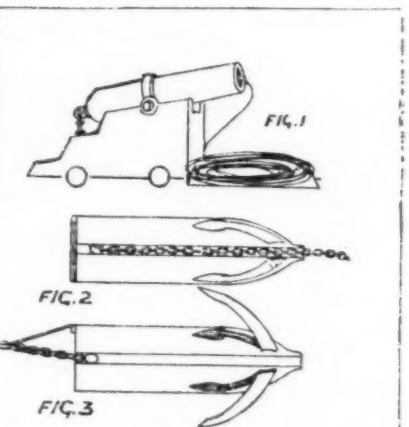
GRAPNEL BOLT AND GUN. (From a sketch by Mr. W. R. Fynmore.)



AUTOMATIC INDICATOR TO PREVENT STRANDING. (From a sketch by Mr. W. R. Fynmore.)



BUOY TO CARRY A LINE AND ANCHOR ASHORE.
(From a sketch by Mr. J. R. Jack.)



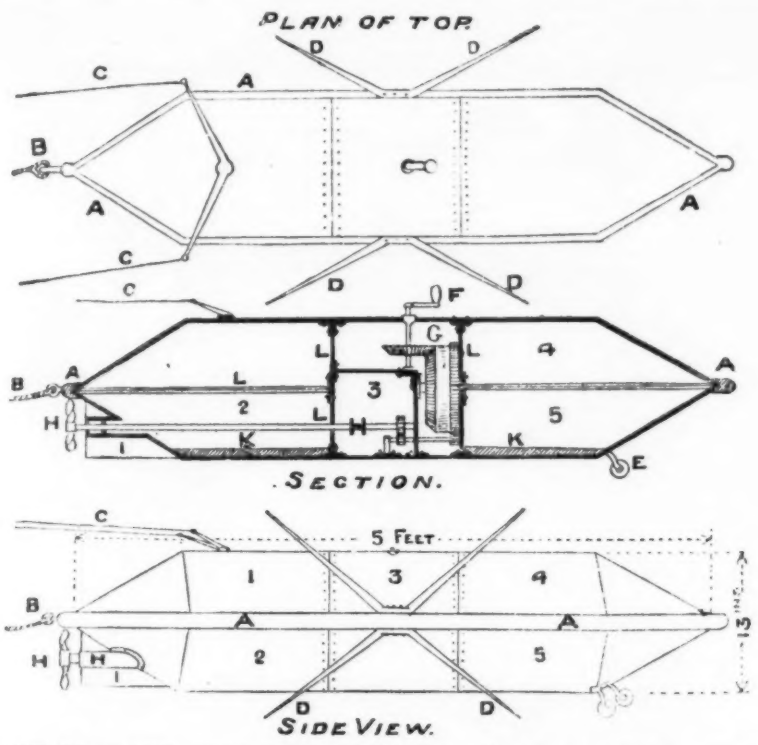
MORTAR AND SHELL TO CARRY LINE ASHORE.
(From a sketch by Mr. J. M. Ross.)

* Continued from SUPPLEMENT, No. 850, page 13576.

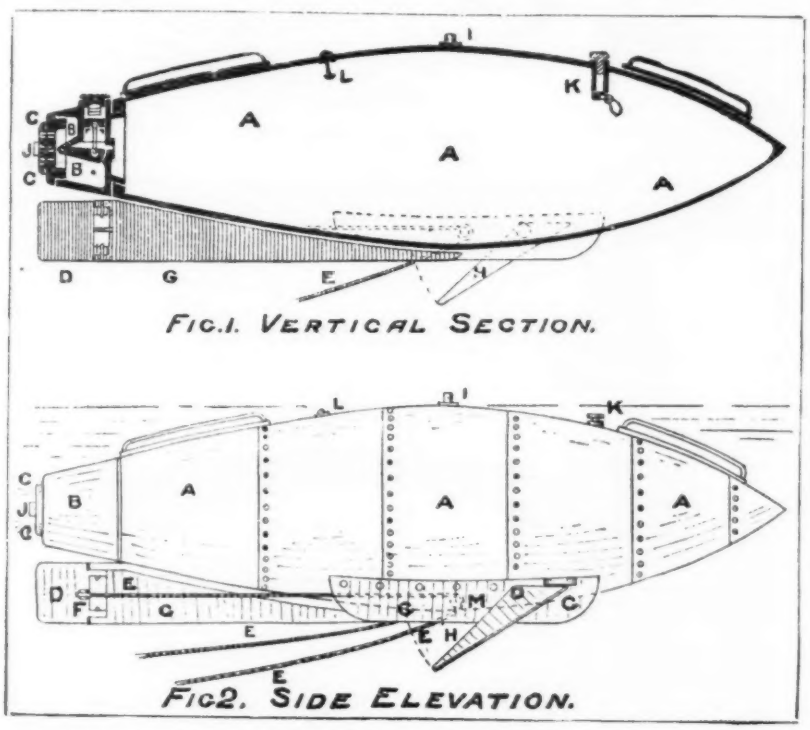
potassium if necessary, to burn in contact with the water.

In Mr. John Mr. Ross' design, Fig. 1 shows the gun or mortar ready for discharging shell to carry the line ashore. Fig. 2 shows a design of a metal shell weighing from 7 lb. to 9 lb., the main feature of which is a recess in the butt, where the wire rope is to be attached

Mr. R. Cadbury, Jr., sends us a sketch of an apparatus he has designed to carry a line ashore from a stranded ship. In the drawings the references are: A, cork band round machine; B, tow line; C, guiding lines; D, arms to catch in shore or other object; E, wheels to enable the machine to run up shore; F, handle to wind spring; G, spring; H, shaft and screw; I, keel only at back; K, leaden bottom inside casing; L, section partitions; 1, 2, 3, 4, 5, sections of machine. Briefly described, the machine may be said to be a clockwork torpedo. When it reached the shore, the arms, D D, would hold it fast whichever side up it may have been thrown on the shore. The guiding lines would be used to direct the machine to the spot on the shore which might be of the most advantage. The wheels would, the designer thinks, possibly help to carry the machine further up shore.

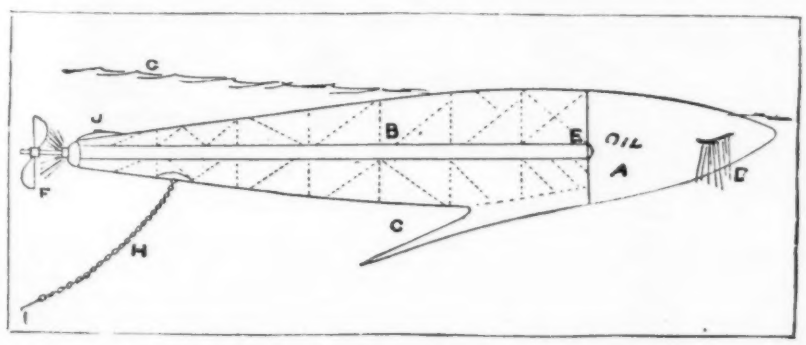


A CLOCKWORK SCREW BUOY WITH GRAPNELS. (From a sketch by Mr. R. Cadbury, Jr.)



A TRAVELING FLOAT STEERABLE FROM SHORE. (From a sketch by Mr. G. Payne Grace.)

Mr. George Payne Grace describes his invention as a traveling float, steerable from the shore, to carry a line to a ship at sea. The design of the float is only described in the lettered references. They are A, reservoir for air; B, reduced pressure chamber and valve; C, air jet orifices for propulsion, adjusted by screw plate, J; D, rudder, worked from the shore by the two steering ropes, E, fastened to the lever, F; M, safety guarded pulleys for steering lines, E, also for pulling a thicker rope when the float reaches a ship; F, lever fixed to rudder and worked by the steering ropes from the shore; G, plates to keep the float steady and act as balance weights; I, socket for flag or lamp; H, pivoted double grapnel to hold the float to the shore; K, orifice and valve for filling with compressed air; L, safety valve.



A SEA ROCKET. (From a sketch by Mr. T. W. Aylesbury.)

The sketch of a sea rocket is from the design of Mr. T. W. Aylesbury. In this a charge of explosive matter placed in the tube, B, propels the rocket, and its speed would be assisted by the stream of explosive matter acting on the auxiliary screw, F. By the means of the oil issuing from the chamber, A, through the distributing valve, D, the passage of the rocket would be made easier. This oil would be discharged in volume upon the fusible plug at E being reached when the torpedo would be at rest. The surface line is shown at G. H is the attach chain for line I, of coir rope. J, vent pan. C, spur grapnel.

LAVAL'S STEAM TURBINE.

THE problem of constructing a thoroughly practical and efficient rotary engine has been tackled by a great number of inventors and engineers without any one having apparently succeeded in solving it in an absolutely satisfactory manner. Don, the American, and Parsons have perhaps got as near as anybody to the solution of the question, having adopted the steam turbine principle.

The ingenious and indefatigable Swedish inventor, Dr. Gustaf de Laval, whose inventions in creamers and other dairy appliances are known all over the world, has for a series of years been engaged on the rotary engine question, publicly exhibiting a steam turbine in connection with his separator as long ago as at the large Stockholm agricultural show in 1886. He has since then followed up the matter, both in theory and practice, and considers now that he has attained a good result, on which he gave an address at the last meeting of the Institute of Inventors in Stockholm.

His 5 horse power rotary engine consists of a small axial turbine, in which, says *The Engineer*, the steam moves almost parallel with the axis. The steam is let in through one or more mouthpieces, which gradually widen toward the turbine. This is one of the main points of De Laval's construction, whereby it is distinctly different from others, and which has been adopted so as to let the steam completely expand, and thereby give it the greatest possible vital power before it comes in contact with the turbine wheel. This wheel, which is of steel or aluminum bronze, has an outer diameter of only 10 cm., and is attached to an axis of 10 mm. diameter.

The enormous speed with which the steam rushes in is attributed to the turbine, which is made to rotate with a speed of 30,000 revolutions in the minute, or 500 revolutions in the second. This is its ordinary speed, but it has, by way of experiment, been raised to between 50,000 and 60,000 revolutions in the minute.

The transmission from the turbine is effected by means of cogwheel gearings, which rotate in oil, and through the medium of which the speed can be reduced as desired. The steam pressure which he has hitherto used is about that of five atmospheres, but the turbine works satisfactorily with a pressure varying between thirty-one and forty atmospheres. The regulator differs from an ordinary Watt's centrifugal regulator principally by half-cylinders having taken the place of balls.

Numerous obstacles and difficulties have placed themselves in the way of the inventor, but one of these has far exceeded the others. The economical working of the invention necessitated an unusual speed of rotation, and this again that the rotating system was completely centered while in motion. Otherwise the turbine might be flung from its place, or its axis, in any case, might bend and at once destroy the bearings. The problem has been solved in the simplest possible manner. The inventor has used the tendency of the turbine and its axis to rotate round its own center of gravity—a tendency which of course increases with the speed of rotation. He has simply made the spindle of the turbine so thin that it will adjust itself in accordance with its center-seeking tendency, without causing too great a pressure in the bearings. Thus he overcame the greatest obstacle in the way of obtaining great speed of rotation and profitable working.

With regard to the latter it is stated that the consumption of steam with the present construction amounts to 23 kilos. per horse power per hour, but that it, by means of already completed improvements, can be reduced to 13 kilos. per horse power per hour—an improvement which will shortly be generally adopted. The consumption of coal per hour and horse power amounts to 3·3 kilos. As compared with recent trials at Plymouth with regard to one-cylinder engines for small power this was very favorable, as the best results at the latter place were with a 6 horse power, which consumed 21·5 kilos. steam per hour and horse power. In practice such a small consumption per horse power by such small engines is quite an exception; and Dr. De Laval hardly thought that 13 kilos. per hour and horse power for a five horse power motor had been seriously thought of before.

De Laval's new turbine claims, consequently, to be more economical than, or at least fully as economical as, the smaller engines hitherto used, in addition to which fact several marked advantages are claimed for it. It is, in the first instance, much more simple than an ordinary engine, which of course consists of far more parts than this turbine. Secondly, it requires a much smaller space, and is much lighter than an ordinary engine of same power. Nor does the turbine cause any vibration, as all the motive parts have an evenly rotating movement and are completely balanced.

A special use of the steam turbine will, thinks Dr. De Laval, be in connection with the working of dyna-

by means of a small shackle. This rope would pass through the groove in the shell. The butt would be hinged and attached to a lever, which would keep in position the claws of the drag when in the gun. Fig. 3 shows the shell after firing. The rope, becoming tight, would lift the butt end of the shell and let go the drags, which would then become of use to drag a man or boat ashore.

mos and other rapidly rotating machines. He also thinks it will be well adapted for marine purposes on account of its even motion and small requirements as to space. Several turbines have for some time worked satisfactorily in Stockholm, eight having been fixed during the present year, and in Dr. De Laval's experimental workshops one has been running for two years and a half.

[FROM ENGINEERING.]

A SHORT HISTORY OF BRIDGE BUILDING.*

By C. R. MANNERS.

THE largest brick arches yet constructed are, I believe, those of the Burneys and Nigul, bridges each 140 ft. span, and erected by Sir James Brown about 1865–

FIG. 51.—COALBROOKDALE BRIDGE.

70, when engineer of the Public Works Department at Kaugra. Germany abounds with good examples of stone bridges and viaducts.

In 1874 a bridge was built at Vevey, in Switzerland, entirely of cement concrete. It has a span of 63 ft. 4 in. on the skew, the angle of skew being 71° 40'. The rise is only 4 ft. 7 in., and the width 36 ft. 5 in. The

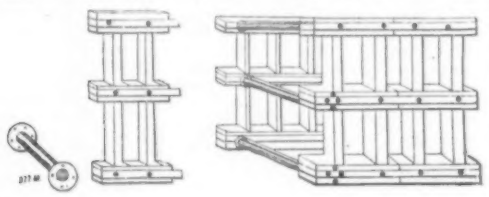


FIG. 53.—DETAILS OF WEARMOUTH BRIDGE.

arch has three successive layers. The structure is in reality a monolith.

The Italians and French took the lead in engineering works down to about the middle of last century and early detected the value of cast iron for bridge construction. According to Ganthey, the construction of iron bridges was first proposed in some Italian works in the sixteenth century and again revived in 1719.

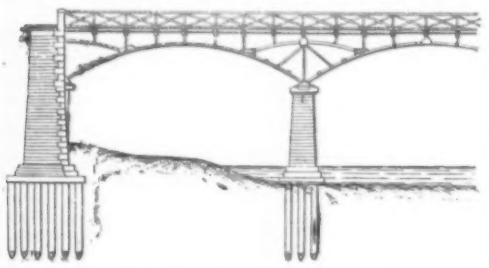


FIG. 55.—PONT DU LOUVRE.

In 1755 an attempt to construct an iron arch was made at Lyons, and the material for one span actually prepared and put together, but the project was abandoned as being too costly.

In 1779, M. Calliffe, a French engineer, designed a wrought iron arch of 656 ft. span, and in 1782 M. Montepetit proposed to construct a wrought iron bridge with two arches of 213½ ft. span for crossing the Seine.

It was, however, reserved for Englishmen to triumph

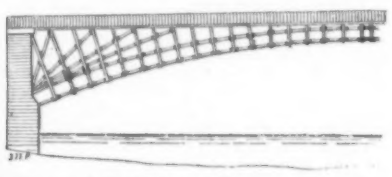


FIG. 57.—PONT DE L'ARCHEVECHIE.

and erect the first iron arch bridge. The first actually constructed was over the Severn at Ironbridge, Shropshire. This bridge was originally designed by Mr. Pitchard, an architect at Shrewsbury, and erected by Mr. Abraham Darby, of the Coalbrookdale Iron Works (see Fig. 51). It was commenced in 1777 and finished in 1779. The span is 100 ft. and the rise 45 ft. There are five ribs, each cast in two pieces and joined at the crown. These are formed by three concentric arcs of cast iron, of which the lower only is entire. The inner or complete arc is 8¼ in. deep and 5¼ in. thick, the others are 5¾ in. square. The design is not very good, but it served its purpose, is still in use, and opened a new era in bridge building. The honor of second place belongs, I believe, to Lower Silesia, or Berlin, as

* Continued from SUPPLEMENT, No. 850, p. 13580.

in 1794 small cast iron arches were erected at both places. The second cast iron bridge erected in this country was a great step in advance. This was the Wearmouth Bridge, Figs. 52 and 53, in the county of Durham, of which Mr. Rowland Burdon, M.P. for the county, was engineer and paymaster.

This bridge consists of a single segmental arch, 236 ft. span, with a rise of 34 ft. It has six ribs composed of cast iron panels acting as voussoirs. These voussoirs are united by wrought iron bars inserted into grooves cast in both sides of the voussoirs and bolted through. The erection of the ribs was so simple that they were all thrown across the river in ten days. It

FIG. 52.—WEARMOUTH BRIDGE.

FIG. 54.—BUILDWAS BRIDGE.

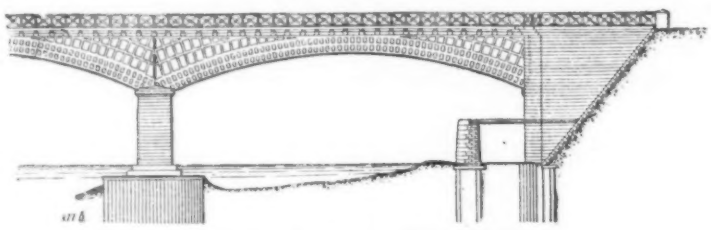


FIG. 56.—PONT D'AUSTERLITZ.

FIG. 58.—CRAIGELLACHIE BRIDGE.

FIG. 59.—SOUTHWARK BRIDGE.

was completed in 1796, at a cost of about £27,000. In 1858 Mr. Robert Stevenson strengthened the bridge by the introduction of wrought iron box girders. In 1795 Telford commenced the next iron bridge, which was also over the Severn, at Buildwas (Fig. 54).

The first iron bridge constructed in France was the Pont du Louvre, at Paris, in 1803. It was 516 ft. long, and has nine arches of 57 ft. span, with rise of 10 ft. 8 in. (see Fig. 55).

Another about the same time, and perhaps prior to the commencement, though not finished until 1806, is the light and elegant structure of the Pont d'Austerlitz (Fig. 56). It has five arches of 106 ft. span and rise of 10 ft. 8 in., and is something similar to the Wearmouth Bridge in construction. In 1805 it was proposed, in order to widen the waterway, to replace the stone bridge "Pont de l'Archevechie," at Lyons, by an iron bridge of novel construction (Fig. 57). This was to be a bridge of three cast iron arches, the center span to be 239½ ft. The arcs or ribs were to be formed of cast iron pipes, two tiers for each rib, connected by radial bars flattened at the ends and bolted between the flanges of the pipes. The haunches and brace framing were also to be of cast iron pipes. This is, I believe, the first proposal to introduce hollow cylindrical members into the construction of iron bridges.

A small bridge of 37½ ft. span was erected on this principle near St. Denis in 1808, by William Brujer. Telford's Bridge at Bonar, in Sutherlandshire, in 1812, and at Craigellachie (Fig. 58), in 1815, each 150 ft. span and 20 ft. rise, show a great advance in the construction of cast iron arches. These arches are composed of four ribs each. The ribs consist of two concentric arcs forming panels which are filled with diagonal bracing. The roadway is formed by another arc of greater radius and the spandrels or haunches are filled with trellis work.

Southwark Bridge (Fig. 59), over the Thames at London, is one of the largest of its class. It was designed by Rennie, commenced in 1814, and completed in 1819, at a cost, including approaches, of about £800,000. The center arch is 240 ft. span, with a rise of 24 ft., and the two side arches are 210 ft. span, with rise of 21 ft. Each arch consists of eight ribs formed of thirteen cast iron segments, 20 ft. long and 6 ft. deep. The spandrels are independent castings. The roadway is 42 ft. wide, and carried on cast iron plates. No provision was made

for contraction and expansion, and this caused some damage to the roadway. Steam pumps were used to keep the inside of the coffer dams dry while the foundations were being got in.

In 1827 the Monk Bridge, at Leeds, 112 ft. span, was erected by Mr. George Leather, C.E., and in 1832 the

FIG. 60.—HUNSLET BRIDGE.

FIG. 61.—COBLENTZ BRIDGE.

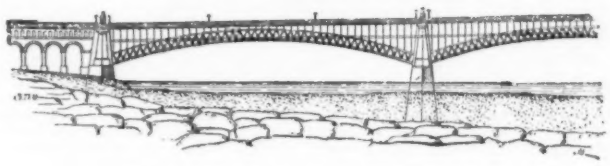


FIG. 62.—THE ST. LOUIS BRIDGE.

bridge at Hunslet, over the Aire, near Leeds, 152 ft. span, was also erected from similar designs by the same engineer (Fig. 60).

These are, perhaps, the earliest examples of roadways suspended from overhead arches of cast iron. Two strong cast iron arches, each in six segments doweled together, span the space between the abutments, and from these the transverse beams which carry the roadway are suspended by wrought iron rods. The arches rest in cast shoes or skewbacks, so arranged that there is practically a ball and socket joint at the springing.

The improvement in the manufacture of iron kept pace with the rapid increase of its application to construction.

Mr. Pope, early in the century, proposed to construct bridges up to 1,000 ft. span, on what was called the "flying lever pendant bridge" principle. These bridges were to be a combination of struts and ties, and so arranged that one-half span was a huge cantilever, while the abutments were to be massive enough to act as counterweights. They were to be built from the abutments toward the centers without the aid of centering.

Wrought iron has gradually superseded cast in the construction of arches, and of these there is a fine example near Coblentz (Fig. 61). It has three spans of 308 ft. each, with a rise of one-eleventh of the span. One of the finest and largest metal arch bridges yet erected is the St. Louis Bridge, over the Mississippi, by the late Captain Eads.

The foundations were carried down to the rock by means of caissons provided with air chambers and locks. The depth below high water was about 136 ft. It has three spans, the center one 520 ft. with a rise of 47½ ft., and the side ones 502 ft. with rise of 46 ft. each. (Fig. 62). The ribs of the arches are of cast steel tubes, an improvement upon the proposed "Pont de l'Archevechie." Each span has four double ribs of these steel tubes. The bridge was opened in 1874.

(To be continued.)

IMPROVED HYDRAULIC DIE PRESS.

THE illustration shows a new design of hydraulic press, made by Messrs. Hayward Tyler & Co., of London, for pressing into cakes all kinds of material, such as chemical powders, tea, etc. It makes the cakes rapidly under any required pressure, and ejects them automatically from the die box. One, two, or four cakes are pressed at a time, according to the size required. The die boxes into which the material is put to be pressed are contained in a revolving table. The illustration shows two pairs of boxes. The press is also suitable for pressing damp or wet materials into dry cakes, as there is an arrangement for getting rid of moisture. A number of these presses have already been made, and are turning out blocks of various materials, ranging from 1 oz. to 2 lb. each in weight. All the motions of the press are made by hydraulic power, and it only requires one connection to the accumulator.

The method of working is as follows: The valve F being opened from the accumulator, the ram G is drawn up by the cylinder H. The material is put into the die boxes A, the valve B is opened, and the table then revolves until the die boxes A are exactly under the ram G. The die boxes A1 have now taken the position of A and are ready to be filled. The valve E is opened, and the ram G then presses the material. The valve D again releases the ram. The table is revolved back again by opening the valve C. The finished cakes are ejected by the ram I at the same time as the new cakes are being pressed. Three boys, one to fill and one to take away and one to operate the handles, can work this press, and produce several thousand cakes a day.—*The Engineer.*

A COLD GALVANIZING PROCESS.

A PROCESS for coating iron and steel with zinc at the ordinary temperature, which presents several points of technical interest, has been lately developed by the London Metallurgical Company. The ordinary method of galvanizing, consisting as it does in the immersion of the articles to be coated in a bath of molten zinc, is by no means free from defects. In the first place, the strong tendency of iron and zinc to form an alloy leads to corrosion of the baths and the goods to be coated, while the comparatively high fusing point of zinc makes it necessary to work at so high a temperature that the temper of hard steel wire is reduced and its tensile strength diminished. Both these evils are avoided in the new process, while other incidental advantages appear to exist. For instance, the tendency to corrode and draw the temper of wire for cables is usually avoided, as far as possible, in the ordinary hot process by keeping the galvanizing bath at the lowest temperature practicable, and running the wire through as fast as is consistent with obtaining a satisfactory coating, practices which induce a considerable waste of zinc on account of the rapid solidification of the metal on the comparatively cold wire. Another result of this is that the adhesion is apt to be poor, and the coating readily parts from the wire when the latter is bent, as it must be during its manufacture into wire rope and its subsequent use in that form.

The appearance of plate coated by the new method is quite different from that of ordinary galvanized sheet. It has a more even and somewhat less brilliant surface, there being an absence of the highly characteristic crystalline spangles usually visible. By the operation of a curious trade superstition, this crystalline appearance is regarded as an indication of good quality, and possibly the less rational among buyers may object to its absence. In the event, however, of this prejudice proving too strong to be combated, it would probably not be difficult to obtain the wished for result by treating the finished goods with a weak acid in the same way as tin plate is treated for the production of *moire metallique*. The matt surface which goods coated without subsequent treatment present can be changed into a smoother and brighter coating by passage between rollers on removal from the bath, the plates then resembling sheet zinc much more closely than ordinary galvanized goods. A further result of the avoidance of the corrosion inevitable with the ordinary method is that fine wire gauze can be coated by the new method, an achievement formerly impossible.

Direct tests carried out on hard steel wires coated by both processes gave the following results:

	Tensile strength.
Steel wire uncoated	165 tons per square inch.
Steel wire galvanized by ordinary process	150 " "
Steel wire coated by new process	165 " "

The same wire was used throughout, and according to these figures suffered no diminution in strength by the London Metallurgical Company's process, while showing a decrease of about 10 per cent. when galvanized in the ordinary way. These figures would be still more interesting if supplemented by those of the torsion test, upon which the users of steel wire commonly lay considerable stress. The hardness of the coating, as determined by Messrs. Stanger and Blount by means of the sclerometer, is slightly greater in the new than in the old method.

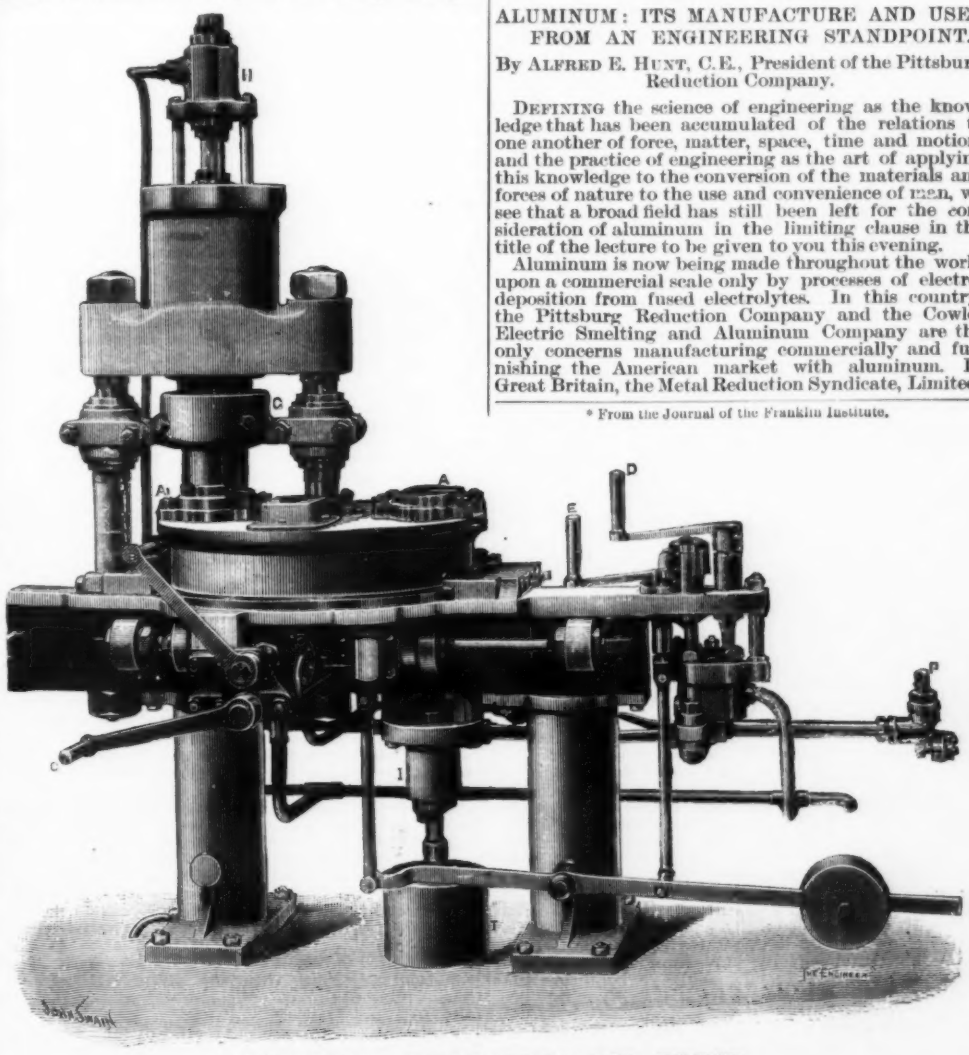
ALUMINUM: ITS MANUFACTURE AND USES FROM AN ENGINEERING STANDPOINT.*

By ALFRED E. HUNT, C.E., President of the Pittsburg Reduction Company.

DEFINING the science of engineering as the knowledge that has been accumulated of the relations to one another of force, matter, space, time and motion, and the practice of engineering as the art of applying this knowledge to the conversion of the materials and forces of nature to the use and convenience of men, we see that a broad field has still been left for the consideration of aluminum in the limiting clause in the title of the lecture to be given to you this evening.

Aluminum is now being made throughout the world upon a commercial scale only by processes of electrodeposition from fused electrolytes. In this country, the Pittsburg Reduction Company and the Cowles Electric Smelting and Aluminum Company are the only concerns manufacturing commercially and furnishing the American market with aluminum. In Great Britain, the Metal Reduction Syndicate, Limited,

* From the Journal of the Franklin Institute.



IMPROVED HYDRAULIC DIE PRESS.

a branch of the Pittsburg Reduction Company; and in Switzerland, the Aluminum Industrie Actien Gesellschaft, manufacturing at Neuhausen, using the water power of the Falls of the Rhine; and in France, the firm of Bernard Brothers, now building a works at St. Michael, and operating the Minet process, are, so far as the writer's knowledge goes, the only manufacturers now whose metal is met in the competition of the world's rapidly growing market for aluminum. These statements need to be made preliminary to any considerations of the purity or other qualities of the commercial aluminum of the markets of the present day, for the reason that manifestly it will not be fair to take into consideration in treating of the commercial aluminum of to-day the impure products made only on a small scale by the great number of processes being experimented upon, and by the many people working upon "The Aluminum Problem," as one of your lecturers, Prof. Richards, has pleased to call the present state of the art regarding the metal. The "problem" of extracting aluminum from some of its compounds, which was first solved by Wohler, in 1827, and later more completely by Deville, in 1854, has now been solved so many times and in so many ways that the task need hardly be dignified with the rank of a "problem" to-day. It takes very little skill with our present knowledge in the metallurgical arts to produce an impure grade of aluminum, as evinced by the many charlatans who are endeavoring to delude the public with their experimental exhibits and brilliant pages of prospectus or newspaper effusions. In the judgment of your lecturer, the aluminum "problems" of to-day are not so much the ways to produce the metal *most cheaply*, as the ways of utilizing the metal in the arts.

In the first of these problems, with great respect and with due deference to their opinions, I disagree with those who have spoken before me from this platform, in their expectation that cheaper methods of production are forthcoming. I am modestly, but firmly, of the opinion that the aluminum problem of the cheapest method of production has been practically solved in the electro-deposition of the metal from fused electrolytes, and that only in details will this method be improved or this part of the aluminum problem be better solved.

I am confident that the aluminum problem of *quality*, as determined by the purity of the metal, has been solved, and that upon a practical commercial scale, too, by several of the later methods of manufacture. At the works of Pechiney & Co., in France, from a date at least as far back as 1882, to my personal knowledge, M. Henri Brivet, their managing director, was enabled to manufacture regularly, by taking the utmost precautions and with carefulness and skill in manipulation as well as in all details of the Deville sodium process of production of aluminum, metal of over ninety-nine per cent. purity, an achievement which, with the knowledge and state of the art of aluminum manufacturing then existing, and with the inherent difficulties of manufacturing pure aluminum by the sodium process, was worthy of the highest praise.

The impurities of the sodium-made metal are about one-half silicon and one-half iron. Both the Aluminum Company, Limited, of Oldbury, and the Alliance Aluminum Company, of Newcastle-on-Tyne, England, made metal and placed it upon the market in 1887 and 1888, of over ninety-nine per cent. purity; and Richards, in his work on *Aluminum*, edition of 1890, p. 246, refers to aluminum made by Grabau by a modification of the sodium process, in 1888, having 99·80 per cent. pure aluminum.

Both the Neuhausen concern and the Cowles, as well as the Metal Reduction Syndicate, Limited, of Patricroft, Lancashire, England, and the Pittsburg Reduction Company, find no trouble by the electrolytic process in producing regularly metal with less than one per cent. of impurity. Indeed, the best results in quantity of output and regularity of working, and therefore in economy of manufacture, are when producing the purest aluminum, and it only requires further development of the manufacture of the aluminum oxide used as the ore and of the carbon anodes—matters which are perfectly practicable and possible—to obtain almost absolutely chemically pure aluminum by the electrolytic methods now in use. The Pittsburg Reduction Company have made a good many tons of aluminum of over 99·90 per cent. purity; and I take pleasure in showing you and leaving for your museum a number of little ingots of aluminum containing no iron, copper or lead, and only eight one-hundredths of one per cent. of silicon, having 99·92 per cent. pure aluminum, by the results of our chemist, Mr. J. O. Handy. With these achievements accomplished, I claim that the problem of quality of the metal as evidenced by its chemical composition has been solved, and solved with fully as much perfection as is the case in the metallurgy of any of the other metals. For with the same amount of care and precaution necessary to produce the so-called chemically pure metals of the markets to-day, by the electrolytic process equally pure aluminum can be produced, and in regular commercial practice aluminum is now being produced as pure in chemical composition as any of the other metals. I make this statement with care, and I think advisedly, being aware that other authorities, for whom I have great respect, have recently written to the contrary. The standard of purity of product obtainable in commercial aluminum having already been established by the processes now extant, and the advantages of the pure metal having become apparent, quite surely any new process to be successful in its competition for the market will have to produce metal of equal purity—a task that will in itself condemn many possibly competing processes. As aluminum is a much more difficult metal to reduce from its ores, under ordinary conditions, than is silicon or iron, almost any reagent or set of conditions that will result in the production of metallic aluminum will alloy with it any iron or silicon that there may be present in the reagents used. This necessitates the materials used being almost chemically pure from silica, iron and other more easily reducible metals—a condition that will add fatally to the expense of many possible processes. The only alternative that seems to me possible is a method yet to be devised of cheaply purifying the metal alloyed with these substances. In fact, in this possibility of obtaining the metal alloyed and impure on a large scale and in a cheap way, and then purifying the aluminum, or a method of manufacture of the aluminum as a by-product of other operations, to my mind rests the only possible competition in process to the electro-deposition from a molten electrolyte.

In the economical reduction of the ores of most metals, one of the most difficult problems to be solved has been the wastage due to oxidation, volatilization or the solvent action of slags, or the impartial reduction or separation and collection of the metal, and its consequent waste in the scoria or refuse product. There are very few metals reduced to their pure state without a wastage of at least ten per cent. In the manufacture of aluminum as practiced by the Pittsburg Reduction Company, there is practically no waste whatever, the waste problem having been by the Hall process entirely solved.

I have already, in a previous lecture in February, 1891, before the Boston Society of Arts, stated that the cost of manufacture under the most favorable conditions with water power, and large output, would be approximately twenty cents per pound. Nearly one year's experience and careful study of the matter leads me to reiterate the statement then made, and to prophesy that the ingot metal will be made by the Hall process within the next few years at *a cost* of between eighteen and twenty cents per pound; the items of cost being about one-third for the ore, one-sixth for the expenditure of other materials than ore, one-third for the electrical current expended, one-twelfth for labor and superintendence, and one-twelfth for general expenses, interest and repairs.

Analyzing these items of cost, the ore will probably be the greatest item of expense in any successful process, and surely the oxide alumina is not only the richest and most easily prepared pure ore, but will prove one of the cheapest, if not the cheapest, of compounds from which to extract the metal. Any methods of cheaper production of alumina from clay or other more abundantly found mineral than bauxite (the hydrated oxide, containing from fifty-five per cent. to sixty per cent. alumina, and with less than ten per cent. silica and iron, the remainder being water), which can be laid down in Pittsburg now in almost unlimited quantities at less than one-half cent per pound, will be equally applicable to the electrolytic as to any other process. Quite surely no difference here in the art will make an insurmountable barrier of cost for the electrolytic processes now in use to compete against.

The expenditure for other reagents than the ore, for carbon and for chemicals, is now less than five cents per pound, with the Pittsburg Reduction Company, and in the estimate can fairly be reduced to three cents per pound for a large plant, with most favorable arrangements made for its supplies. In the item of electrical power, there certainly may be room for a curtailment of cost; but even should this expenditure of electrical power be lessened one-half, or entirely done away with, heat alone being substituted as the energy for reduction of the ore, it will be difficult to conceive of a method that would not require a cost of at least one cent for this heat, which would be a saving perhaps of four cents per pound upon this item of electrical power. However, I feel confident that should such processes be devised, the increased expenditure for chemicals and other reagents, besides the amount quoted as necessary for the Hall electrolytic process, will nearly if not quite counterbalance the saving in electrical energy expended in the Hall process.

In the items of labor, superintendence and general expense, interest, and repairs, there may be a small saving made by a process yielding metal more rapidly than by the comparatively slow electrolytic process.

I would, however, here call attention to the fact that our present experience leads me to believe that the items of labor and superintendence will quite surely be reduced to between two and three cents per pound of metal produced, and the amount required for general expenditure, interest and repairs to no larger than an equal expenditure, when the metal is made upon a very large scale. Again, these are necessary and inherent items of cost of any method of manufacture, and the amounts that can be saved here by other possible means of manufacture, in my judgment, will prove very small indeed, surely not more than three cents per pound at greatest—an amount which I grant might at some future time of competition be a fatal one to the higher cost parties, but would not be such an amount as to lead to such startling changes in the selling prices of the metal, beyond what can be done by the electrolytic manufacturing interests, as one would be led to believe by the prophets who have gone before me. With the cost of manufacture being the ore at six cents per pound of metal made, and subject to almost any possible lowering of rate applicable to any other process, the power and materials used at eight cents, and the labor and all remaining expenses at between four and six cents per pound—cost items that I believe will be obtained gradually within the next few years by the electrolytic methods of production—I do not believe that there will be other methods devised to successfully compete with their totals of cost per pound. The average energy expended per pound of metal produced by the Pittsburg Reduction Company is about twenty electric horse power hours, or each electric horse power hour of energy exerted upon the electrolyte yielding about twenty-two and seven-tenths grammes of metal. Each month, by new experience, we are adding to this efficiency, and we confidently hope to make a gain of at least ten per cent. upon this record soon; and I shall not be satisfied until this gain in efficiency shall reach at least twenty-five per cent. over present rates.

Our compound engines have a record of two pounds of coal per indicated horse power hour, and with a twenty per cent. loss of potential in conversion of indicated horse power into electrical—an estimate that is very liberal—we have twenty-four indicated horse power hours per pound of aluminum produced, or an expenditure of forty-eight pounds of coal, which costs us eighty cents per ton at our works, or an expenditure for fuel of less than two cents per pound for the aluminum produced. Of course, to this has to be added labor, water (which we pump direct from the adjacent Allegheny River) and repairs—items which count up considerably upon a plant of only 600 horse power; but with a large plant will bring the cost for power per pound of aluminum very low, and at a rate which will compare, especially if triple expansion and condensing engines are made use of, very nearly equally with the cost of the best water-powers. With water powers, of which there are several of over 1,000 horse power each in the country, available at rates of from $8 to $15 per horse power per annum, we can reckon on the cost of the electrical energy per pound of aluminum at between two and three-quarters and three cents per pound of metal made. Undoubtedly, the splendid power to be developed at Niagara will prove one of the best in the world for the manufacture of aluminum.

At these rates, a margin of nearly 100 per cent. is allowed in the estimate given above for the cost of the electric power, for a plant manufacturing aluminum by the Hall process under the most favorable conditions.

I do not, however, much fear the solution of this portion of the "aluminum problem" adversely to the interests of those of us who are engaged in the electrolytic method of its manufacture. I assure you that I do not thus confidently assert the courage of my convictions without a reason therefor. I have recently read over the historical portions of articles on aluminum in the world-famed *Journal of the Franklin Institute*, and with trepidation noted that it was possible to read the epitaph of all the methods of manufacture which started before the present ones of electro-deposition from molten electrolytes; many of them in the light of their day with even more of bright prospects of financial and metallurgical success than these now extant. I have noted that while Prof. Henderson was reading his able article before your Institute, in October, 1888, on aluminum, in which he speaks of the improved Deville sodium methods as the ones *de facto* supplying the world's aluminum of that day, the metal was then being regularly made by a cheaper method, and a commercial works within a month more was in operation, manufacturing upon a larger scale than ever before, by the electrolytic method that was to entirely supersede the improved sodium processes. Perhaps a similar fate hangs over this paper and its author. I am aware that precedent, as well as popular (and to a considerable extent scientific) opinion is against me, and I can assure you that it would take much less courage for me to acknowledge the probability rather than to assert the improbability of a cheaper and better process, yet I am constrained to take the position that I have, with the hopes of turning the inventive and skilled as well as the popular attention to the fact that the next great source of cheapening aluminum will be a large demand for the metal, at present prices, sufficient to warrant outlay in plant to very greatly increase the capacity for manufacturing the metal. Aluminum will not be manufactured by any process at much less than at present, nor will it be sold at much lower rates, until the output be measured in tons, and not pounds, per day. The lowering of the market price of aluminum in the future will be gradual, and will be directly proportionate to the decrease in cost of manufacture, due to increased capacity of the manufactories.

Just as the widespread acceptance of inaccurate and misleading information regarding the properties of the metal hindered the development of the uses of aluminum in the arts, so at present the widespread forecasts of the metallurgical prophets, that the stars of new and much cheaper processes of manufacture are above the horizon of their horoscopes, without so much as vouchsafing us any tangible reasons therefor, are equally hindrances in that they discourage the expenditure of capital necessary to develop the manufacture of aluminum upon a scale sufficient to materially reduce the present manufacturing costs of the metal. The many brilliant new projects backed by scientific experts for manufacture of aluminum at wonderfully low costs, which flash out in newspapers like meteors in the sky, and die out as rapidly, do much not only to hinder capital entering legitimate aluminum industries, but in deterring consumers from using or carrying any stock of a metal whose selling price they are led to believe may any day be reduced very much more than any possible gain their fabrication upon it may be to them.

In my judgment, the aluminum problems of by far the greatest moment yet remaining to be solved are in connection with the development of the uses of aluminum in the arts. Much has already been done in this matter, the demand for the metal increased tenfold over any previous year in 1891, yet very much more remains to be done. Undoubtedly much has yet to be developed in details in the economical production of aluminum; probably very few realize that more than your lecturer. At the same time, the problems involved in the development of the uses of aluminum in the arts have been underestimated, and have not received the intelligent consideration that the importance of the subject warrants. The world has been centuries learning to use other metals; we have a right to expect more rapid development with the increased general knowledge of to-day, yet it will at best take time to open the entire field that the metal is destined to fill. Within the past ten years, there have been two popular widely spread ways of solving this portion of the "aluminum problem," which are superficial, erroneous, and a hindrance to the true solution of the problem. The first, assuming properties for the metal that it did not possess, proclaimed that aluminum would, as soon as it could be produced in sufficient quantities, replace all other metals in the arts, not only for the special purposes where the higher grade metals are now used, but also for structural and building purposes, to replace iron and steel; the second view of the subject (the natural reaction from the first erroneous one has become current within the past year or two, as the people began to use aluminum and found their ideals regarding it shattered) is to the effect that the metal has little or no use in the arts.

The reasoning for the first popular erroneous answer to the problems involved in the development of the uses of aluminum in the arts was that aluminum was by far the most abundant of all the metals in its distribution in the earth's crust, and *consequently* should be the cheapest. Confusing the comparison of strength of materials, section for section, with equivalent weights, forgetting to take into account its low elastic limit and modulus of elasticity, or modulus of resilience, or its lack of rigidity under compression strains, or its natural softness, but noting that the metal withstood the ordinary atmospheric and other usual conditions of corrosion with considerable efficiency over other metals commonly used in the arts, the enthusiastic conclusion was reached that we were rapidly leaving the "steel age,"

as we had the "iron age" before it, and were advancing upon the "aluminum age," "where this wonderful metal should supersede all others for almost all the uses of mankind." It is surprising that some of the hopeful ones did not propose to mould up the clay banks into buildings and railroads and other useful contrivances, and turn on the electric current and produce the aluminum structures *in situ*.

As instances of the second view of the case that I am sorry to say has become quite fashionable of late, as shown by the frequent publications in trade journals, a writer in a recent German publication, disappointed in his ideals regarding the solubility of the metals in acids, and finding that aluminum could not be used as a substitute for platinum in acid stills, immediately jumps to the conclusion (and publishes his conclusions broadcast) that the metal is entirely unsuitable for culinary utensils, seemingly forgetting that cooking operations are not conducted in muriatic, nitric, or even in sulphuric acid, as dressings or gravies, and not considering it necessary to investigate the action of these acids or their salts upon the metal in quantities and under conditions similar to those the metal would in any likelihood be subjected to in actual use in culinary utensils.

Another writer has gone through a long list of experiments, heading his table of results "Solubility of Aluminum in Acids," using aluminum *foil* and finding that in from two to four days the foil was dissolved in from one to ten per cent. solutions in water or many organic acids, such as formic, acetic, butyric, lactic, tartaric, citric, oxalic, palmitic, stearic, gallic, salicylic, carbolic, boric, etc., he wisely proclaims that these results show that this metal is unfit for canning materials, cooking utensils, or any chemical laboratory purposes. This writer forgets to investigate the differences between foil and thicker plates before drawing his conclusions, nor did he inquire as to the action of these same reagents upon equally thin foil sheets of other metals now used for the operations he describes. Had he done so, he would have found that in the sections used in utensils of other metals, aluminum withstands the action of all the reagents mentioned as well as do the metals now in common use; and as for the action of ordinary solutions on thin foil, tin, iron, and copper are fully as rapidly acted upon as is aluminum. Aluminum has neither taste nor odor, nor are its salts (in small quantity) especially poisonous, as are the salts of other metals now more commonly used.

Aluminum is not much more acted upon than is tin, copper or silver by salt water, and even by such solutions in vinegar as the metal is liable to be subjected to in ordinary culinary vessels. The salts of tin or copper thus dissolved are very poisonous; but not only are the aluminum salts that are formed less in amount, but the acetate of aluminum formed resolves itself on boiling into either an insoluble subacetate or into pure alumina, neither salt having either taste or injurious toxic action. For these reasons, quite surely aluminum will have a large future for cooking utensils.

Aluminum cooking utensils have been used in my own home for the past two years, almost altogether, being subjected to all the usual materials that varied household uses subject them to, including plenty of good soap and water and scrubbing, and none of the vessels are in the least corroded. Aluminum spoons have been subjected to treatment with vinegar in comparison with silver spoons, and have withstood the ordeal equally as well, and are in constant use in my own home.

A careful and intelligently chosen course regarding the development of the use of aluminum in the arts, the medium of the two above referred to, determining the uses for which the metals shall be utilized in the arts from a reasonably accurate knowledge of the properties of the metal and the requirements that will be demanded of it in its proposed applications, is the task to be accomplished in solving this portion of the "aluminum problem." Considerable has already been done in this work, and fortunately the problem is applicable to a multitudinous subdivision among the world's workers. Nothing is gained in advancement of the knowledge, welfare or skill in the arts, in the world's rapidly developing needs, except at somebody's cost.

"Not a truth has to science or art been given,
But brows have ached for it and souls have toiled
and striven."

There is much yet to be done along these lines in solving this portion of the "aluminum problem." I believe this field to be a richer one and will yield better results to the successful investigators of the future than the one of endeavoring to find a new and more economical method of manufacture of the metal.

The late James Nasmyth epigrammatically said that "engineering is common sense applied to the use of materials." Had he added the word *intelligent*, his definition seems to me would be well nigh perfect, and that portion of my subject which referred to the "uses of aluminum from an engineering standpoint" could be stated in terms of this definition as follows: *common sense applied to the intelligent use of aluminum.*

It is along these lines that I wish to make a plea for the metal to-night, that the public interest that is now so widespread, and the work of the many inventors who are now so earnestly struggling with the "aluminum problem," be turned in this seemingly new direction of attacking the metal from an engineering standpoint—that is, exercising "common sense applied to the intelligent use of the metal."

The principal impurity of the commercially pure aluminum of to-day is silicon, which exists in two forms, one seemingly combined with the aluminum, as combined carbon exists in white pig iron, and the other in an allotropic graphitoidal modification. These two forms of silicon seem to exert somewhat different effects by their presence in the aluminum; the combined form of the element rendering the metal much harder than the graphitoidal variety. The combined silicon ordinarily preponderates, being fifty-five per cent. to eighty per cent. of the total silicon in the metal of ninety-nine per cent. purity made by the Pittsburg Reduction Company. The graphitoidal silicon is separated on dissolving aluminum in hydrochloric acid as a black insoluble residue, and appears like graphitoidal carbon on similarly treating gray cast iron; in fact, it has been mistaken for carbon by many superficial or ignorant observers. Carbon does not unite with aluminum except at very high temperatures, and its influence seems to be to make the metal very brittle. Metal containing carbon can readily be told by its abnormal crystalline and peculiar colored fracture.

In the electrolytically made commercially pure aluminum of to-day, the only other impurity is iron, which, if it exists in larger quantity than five or at most ten one-hundredths of the one per cent., is the result of carelessness in manufacture, or the selection of needlessly impure alumina ore or carbon anodes. The presence sometimes found of copper or lead in any quantity in the metal is the result of needless contamination with these elements in the preparation of the ore or the carbon anodes, or in the manipulation of the pots. By allowing the pots to run for a considerable time without ore, and with a high current and very hot electrolyte, as sometimes occurs in careless working of the pots, metallic sodium has been alloyed with aluminum in noticeable percentages. Upon placing such metal in hot water, the sodium will be rapidly dissolved out with considerable effervescence, and the pure metal left spongy, honeycombed and weak.

For many purposes, the purest aluminum cannot be so advantageously used as that containing three per cent. or even four per cent. of impurity, as the pure metal is very soft, and not so strong as the less pure. It is only where extreme malleability, ductility, sonorousness, or non-corrodibility is required that the purest metal should be chosen. For most purposes a small percentage of other elements than silicon and iron are advantageously added in producing hardness, rigidity and strength. Titanium, chromium and copper can readily and cheaply be added, and are constituents that will not detract from the non-corrodibility of the metal as much as do these natural impurities that come from the ore and apparatus—additions that will give the aluminum a better color and greater strength and hardness, with proportionately less sacrifice of malleability, ductility, etc.

(To be continued.)

TECHNICAL EDUCATION.*

By Prof. GALBRAITH.

THE word technical is derived from the Greek τέχνη, an art, handicraft or trade. The idea involved in this word is the bringing forth or making of material things as distinguished from thoughts and mental images. It is not always safe, as you know, to infer the modern meaning of a word from its derivation. Nevertheless it happens that one of the great branches of technical education, as at present understood, is exactly defined by the old Greek word, namely the training of apprentices in the arts and handicrafts. Technical education in this sense has been in existence since the days of Tubal Cain, the instructor of every artificer in brass and iron; and to it we owe the greater part of the material progress which has been made since the world began.

In these latter days, however, a new application has been found for the term. In consequence of the growing competition for trade among civilized nations, and the recognition of the relations of art and science to production, schools for giving artistic and scientific training to those engaged in industrial pursuits are becoming acknowledged as one of the necessities of modern times. These are known as technical art schools and technical science schools. It is to the latter alone that I propose to direct your attention this evening.

From the time of the revival of learning in the middle ages down to the present century the energies of the universities and schools have been directed in channels having little or no connection with the material necessities of civilized beings. The sole exception has been the schools of medicine. That this should have been so may seem strange, but it appears to me that we have not far to go for the explanation.

The universities and schools are not the originators of knowledge. They are simply collectors and distributors. Natural science is a thing of modern growth. It had to reach a certain stage of development before the community could become interested in it; and not until a demand for scientific knowledge had been created could it be admitted into schools of learning. How long, for example, is it since the physical sciences have been made a part of our Ontario school curriculum?

Herbert Spencer, in an essay on education, says: "That which our school courses leave almost entirely out we thus find to be that which most nearly concerns the business of life—all our industries would cease were it not for that information which men begin to acquire as they best may after their education is said to be finished. And were it not for this information, that has been from age to age accumulated and spread by unofficial means, these industries would never have existed. Had there been no teaching but such as is given in our public schools, England would now be what it was in feudal times. That increasing acquaintance with the laws of phenomena which has through successive ages enabled us to subjugate nature to our needs, and in these days gives the common laborer comforts which, a few centuries ago, kings could not purchase, is scarcely in any degree owed to the appointed means of instructing our youth. The vital knowledge, that by which we have grown as a nation to what we are and which now underlies our whole existence, is a knowledge that has got itself taught in nooks and corners, while the ordained agencies for teaching have been mumbling little else but dead formulas."

It seems to me that these words of Spencer should be taken rather as an indictment of the community than of the schools. There has been, and may yet be to some extent, opposition on the part of men permeated with the older culture to the introduction of the physical sciences into the schools, but this opposition is disappearing as the sciences grow and prove their fitness for a place in the educational system.

One of the main obstacles to the introduction of the teaching of science, even after its importance had been fully recognized, was the large outlay required for the necessary apparatus. Scientific investigation is both qualitative and quantitative. The teaching of science on the qualitative side consists in the enunciation and illustration of principles. The apparatus required for this purpose is comparatively inexpensive, and may be improvised to a great extent by the teacher. In many cases no apparatus at all is required—simple observation of natural phenomena being sufficient. The case is altogether different when the principles of science are to be investigated quantitatively. Instruments for making precise observations and measurements must be used. These instruments are expensive and cannot be made by teacher or student. The highest mechanical skill is required for their manufacture, and patience, time and opportunity for their use. Laboratories have to be equipped, and the whole time of teacher and student given up to work with the hand, eye and ear.

It is not to be wondered at that the introduction of science into the curriculum has been slow. Now that it has been accomplished the question naturally arises, Wherein exists the special necessity for the establishment of technical scientific schools? I think it may be answered thus:

In all schools for the teaching of professions and callings, whether we choose to consider them technical or not, it is an admitted necessity that the teachers should be practical men in such professions and occupations. What would be thought of a medical school in which the teachers were not physicians? Of a law or divinity school in which they were not lawyers and theologians? In like manner the teachers in technical schools should be engineers, architects, manufacturers, artisans, miners and agriculturists if it is possible to get them. The difficulty which exists at present to a large extent, but which will disappear with the progress of technical education, is that there are very few men in the above professions and occupations who have had a sufficient training in science to make them successful teachers—their knowledge is practical, not scientific. The teacher in a technical school should be more or less acquainted with the various trades—with the methods in vogue for handling and transforming material. He should know how things are done and made in actual life and on the commercial scale. He ought to have a better perspective, so to speak, than the purely scientific man in reference to the needs of his students, and should be able to meet them more nearly on their own plane, and interest them in science by selecting his illustrations from their work, actual or prospective. It is of the first importance that he should keep himself informed in the latest manufacturing processes. This cannot be done by reading. The text books are always years behind the times in this respect. Manufacturing and engineering periodicals are better, but still they convey little or no idea of the scale on which work is done. Personal observation, travel, and engaging in outside work whenever possible are the only methods whereby the teachers in technical schools can gather the proper material for illustrating scientific principles and maintaining the interest of students in their work.

The principal work of a technical school is the teaching of science, and not, as many suppose, to turn out fully fledged engineers, architects, manufacturers and tradesmen; all that it can pretend to do is to turn out partially educated men. The graduates must supplement the work in the school by practical experience in after life before they acquire the right to call themselves practical men.

The practical work of the school differs in many respects from the practical work of actual life. Where it is work of the same kind, as for instance drawing, designing, the use of surveying instruments, lathe work, smith work, etc., yet the feeling of reality and responsibility is lacking. It is a very different thing to make mistakes in school work from making mistakes in similar work in actual life. A man is vastly more impressed by the necessary punishment which follows mistakes in the serious business of life than he can be by the arbitrary penalties instituted by the faculty.

Again there is a great body of knowledge necessary to complete a man's practical education which it would be only an utter loss of time to attempt to give in a school, simply because there are no well defined threads of scientific thought upon which to string it. Three-quarters of the information to be found in an engineers' hand book would be useless in the curriculum, although all-important in practice. Such knowledge becomes useful only when impressed by experience.

The establishment of engineering laboratories marks a new departure in technical education. Surely it will be said, the work in these laboratories is practical. So it is, but not perhaps in the sense in which the question is put. The steam engine in an engineering laboratory is not used for the same purpose as the factory engine. In the shop it is used for manufacturing purposes; it is placed in the laboratory for the purpose of being experimented upon. In the laboratory it is tried at different speeds, worked condensing and non-condensing, with varying steam pressures, with and without steam-jacketing, with different amounts of lead and cushioning, with different counterbalances for crank and connecting rod, with varying clearances, with simple and multiple expansion. The work done at the main shaft is accurately measured; likewise the work in the cylinder—the feed water and condensing water are weighed—the degree of dryness of the steam determined. In short, in the laboratory all the conditions which may affect actual practice are experimentally investigated. It is only in this way that the principles governing the construction and action of engines can be fully determined.

What would an employer do with a man who should attempt any such work with the factory engine? He would simply give him to understand that his usefulness was gone, and that he had better look for employment at the School of Practical Science.

Again, since the teaching of principles is the main object of a school of applied science, it seldom happens to be useful to complete any of what is ordinarily called practical work, as would be necessary in actual life. To do so would occupy too much time. Practical constructions involve so many and various considerations and methods that the attempt to complete them would simply be reverting to the old state of affairs when the apprentice gained his knowledge altogether on actual work. The study of the sciences would be so much interrupted and confused by such a method as to be of very little value. The practical work of a technical

* Abstract from an address delivered by Professor Galbraith, at the opening of the engineering laboratory of the School of Practical Science, Toronto, February 24, 1892.

school in so far as it is of the same kind as that of after life must be selected and pursued rather as illustrating the principles of the special science under consideration than for the sake of the work itself.

In practical life, on the other hand, the result is the thing aimed at, and it matters nothing to those who pay for this result how it was arrived at, whether by rule of thumb or by the application of scientific principles. The work of the school is more analytic than synthetic, more destructive than constructive. The student pulls, as it were, machines to pieces in order that in after life he may learn to put them together. His proper work is investigation and experiment. After he graduates, his work on the contrary is construction and design. It would not be advisable to give equal prominence to both kinds of work in the school. The time is too short and the feeling of responsibility which should govern construction and design is absent and cannot be artificially excited. Make-believe work is essentially false and unscientific.

The arrangement of the courses of study in the School of Practical Science is in accordance with these principles. The departments of instruction are civil, mining, sanitary, mechanical and electrical engineering; architecture, analytical and applied chemistry, and mineralogy and geology.

In addition to the instruction given in the school the students take such work in the University of Toronto as is necessary. The university work is mathematics, physics and chemistry. Up to the present session mineralogy and geology have also been taken in the university. The greater part of this work will henceforth be taken in the school.

Through the exertions of the Hon. the Minister of Education and the liberality of the Provincial Legislature an engineering laboratory has been established, now approaching completion. The Dominion government have also contributed their quota by relieving the school from the payment of customs duties on such apparatus and machinery as it was found necessary to import from abroad.

It may be of interest to you to have a short description of the main features of this laboratory.

It consists of three departments: First, the department for testing materials of construction. Second, the department for investigating the principles governing the applications of power. This department is subdivided into the steam laboratory, the hydraulic laboratory and the electrical laboratory.

The third department may be termed a geodetic and astronomical laboratory, as the work to be done in it, which relates principally to standards of length and time, is of special importance in these sciences.

In order to prepare specimens for the testing machines a shop has been fitted up with a number of high class machine tools specially suited for reducing the specimens to the requisite shapes and dimensions with a minimum of hand labor. It is also fitted with the necessary appliances for making ordinary repairs.

The machines in the department for testing materials are the following:

An Emery 50 ton machine built by Wm. Sellers & Co., of Philadelphia, for making tests in tension and compression.

A Riehle 100 ton machine for making tests in tension, compression, shearing and cross breaking. It will take in posts twelve feet long and beams up to eighteen feet in length.

An Olsen torsion machine for testing the strength and elasticity of shafting. This machine will twist shafts up to sixteen feet in length and two inches in diameter.

The last machine in this department is a Riehle 2,000 lb. cement testing machine. The cement testing laboratory is fitted with the usual accessories.

These machines are all of the latest and most improved designs, and with the exception of the cement machine there are at present no duplicates of them in existence.

In the power department there are under the division steam, two boilers, a Babcock & Wilcox fifty-two horse power and a Harrison Wharton twelve horse power boiler. The engine is a fifty horse power Brown automatic cut-off engine built by the Polson Iron Works Co., Toronto, specially for experimental purposes. It is steam-jacketed and has three alternative exhausts, to the open air, to a jet condenser and to a Wheeler surface condenser kindly presented to the school by Mr. F. M. Wheeler, of New York, the inventor. There are also a Blake circulating pump, a Knowles air pump and a Blake feed pump, the latter of which was a gift from the manufacturers. The engine is arranged so that it may be compounded when there are funds for the purpose. To have built the engine compound in the first place was deemed inadvisable, as the money was urgently needed for other work.

A machine now being constructed by the Riehle Bros., of Philadelphia, for measuring journal friction and testing lubricants, will shortly be placed in position. It is fitted with an ordinary railway car journal and box. The maximum loads occurring in practice can be applied. The maximum speed will be 50 miles an hour. This machine is expected to be an improvement upon any yet built for a similar purpose. I received a letter a few days ago from a railway in the Western States which intends to order one if we give a satisfactory report.

The hydraulic division of the laboratory is furnished with a three-throw pump with double-acting cylinders, built specially for the school by Northey & Co., of Toronto. It has adjustable strokes and has a maximum capacity of half a million gallons per day. It has been designed to produce an extremely steady pressure, this being requisite for hydraulic experiments. The maximum head under which it works is 200 feet. There will be practically no addition to the running expenses of the laboratory due to the working of the pump, as the same water will be used over and over again, and the power will be furnished by the experimental engine. In order to make engine experiments the coal has to be burned in any case and the necessary resistance supplied either by brake or otherwise. Driving the pump is one method of doing this. A three feet turbine wheel of the jet type, built by the Fensom Elevator Co., of Toronto, forms a part of the same equipment. The pump furnishes the power for this wheel. There are two large tanks built by the Doty Engine Co., of Toronto, for experiments on the discharge of water through orifices and over weirs.

The above apparatus is arranged with a view to testing water meters, measuring the discharge of fire streams and various other hydraulic investigations within the capacity of the plant.

The electrical division of the laboratory is equipped with the following dynamos:

Edison, Ball, Thomson-Houston, two Gulcher machines and a Westinghouse alternator with transformers, a Crocker-Wheeler and a Kay motor, also two small fan motors.

There are in connection with it a Roberts storage battery, a gravity primary battery and a fair equipment of lamps, arc and incandescent, of different types.

The power department is equipped with the usual measuring instruments, indicators, gauges, gauge testing apparatus, scales, brakes, dynamometers, ammeters, voltmeters, resistances, galvanometers, etc.

In the geodetic and astronomical department are 100 feet and 66 feet standard of length; a 10 feet Rogers comparator with graduating attachment; a Howard astronomical clock and electro chronograph; a Troughton & Simms 10 inch theodolite, and all the ordinary surveying instruments.

That you may not leave this building to-night under the mistaken impression that our equipment is complete, and that we can spend no more money, I propose to conclude this paper by touching upon some of our most pressing wants.

The department of architecture has recently been established and is provided with a good collection of photographs and drawings. A large number of casts, models and plates will be required, however, to complete the equipment.

The oldest laboratory in the school is that in the department of analytical and applied chemistry. It is well equipped for general work in qualitative and quantitative analysis; also for the quantitative analysis of food, air, water, fuels and illuminating gas. Special apparatus is now urgently needed for the analysis of iron, steel, and other materials of construction to supplement the testing work of the engineering laboratory.

The important department of mineralogy, assaying and mining has at present a very meager laboratory equipment. In view of the interest which is now being taken in Canadian mining, it is to be hoped that this state of affairs will be immediately improved, and that the School of Practical Science may be enabled during the next session to offer to those who may desire it a complete course of instruction in mining engineering and metallurgy.

In sanitary engineering we have at present no special laboratory. Our hydraulic plant can be utilized largely in connection with this department, but in addition a collection of models is very necessary for purposes of illustration.

As cities increase and population grows denser, sanitary problems become more complicated and have to be dealt with by communities and governments instead of depending on individual action. As a consequence, sanitary engineering is becoming a most important branch of the profession, and a prominent position should be assigned to it in the curriculum of a technical school.

The rapid development of electrical lighting is bringing into prominence the question of the measurement of the illuminating power of electric lights. Special difficulties surround this problem, and it is desirable that our electrical laboratory should be furnished with the means for making such investigations.

It would greatly facilitate the work of the school in all departments to have means for making photographic lantern slides. Ordinary charts and maps soon grow out of date and take up a large amount of room. A photographic outfit would give the means of making lantern slides of all the latest illustrations of machinery and construction that are published in engineering, manufacturing and architectural journals and of exhibiting them to large classes.

Another pressing want is a good technical library. If it were not for our periodicals, we should have no library at all; and while the Toronto Public Library has a good collection of works on technical subjects, yet they are for all practical purposes beyond the reach of our students.

Collections of rocks, minerals and products illustrating various stages of manufacturing are very much needed in the departments of mining and applied chemistry.

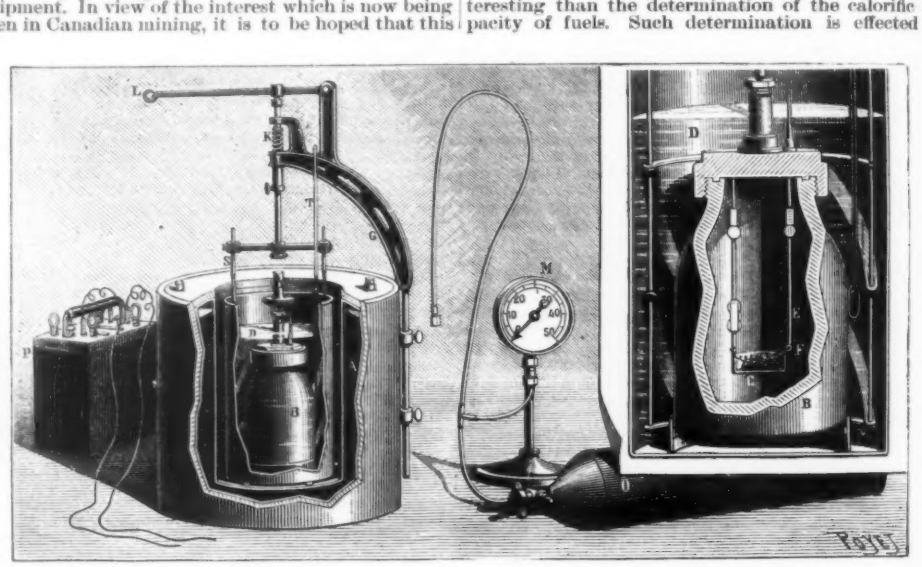
In view of these pressing demands the question will naturally arise, What is to be the outcome of this technical education—where are the young men to find employment? If the country cannot support them, what justification can there be for the expenditure? It seems to me that this is a question in political economy and might properly be referred to the distinguished head of that department in the University of Toronto or to our friends the Trades and Labor Council.

My answer can be only vague and general. I would reply by asking why we have gone into debt for the purpose of building canals and railways, docks and harbors—why have we built expensive houses of parliament, churches and jails, sewers and water works, colleges and poor houses? Is it not because we feel that we are as good as our brothers across the sea or as our cousins south of the lakes—are we not a civilized people, and have we not a right to these luxuries, whether we can pay for them or not? Is it not as useful to the country to turn out men educated as engineers, architects, mechanics, miners and farmers as to turn out lawyers, doctors, ministers and bankers? Will not the graduates of our technical schools have that very education which our mechanics, artisans and tradesmen of all classes most desire, and of the necessity for which they are reminded every hour? If you had seen with me the crowd of eager men, young and old, who assembled the other evening at the opening of the Toronto Technical School, you would no longer have any doubt as to the desirability and necessity of technical education. If the country cannot support such men, so much the worse for the country, and so much the better for that country in which they find employment.

If we are ever to pay off our foreign debt and trade on equal terms with other nations, we must develop our material resources with economy and skill, and among the means making toward this end not the least promising is technical education.

APPARATUS FOR THE INDUSTRIAL DETERMINATION OF THE CALORIFIC POWER OF FUELS.

INDUSTRIAL physics presents no problem more interesting than the determination of the calorific capacity of fuels. Such determination is effected at present either by the Berthier process, which is inexact, or by means of elementary analysis, which is delicate and takes long to perform. Precise results may be easily obtained by the use of Mr. Berthelot's calorimetric bomb, but the apparatus of the College of France is too high priced for the finances of industrial laboratories, on account of the large quantity of platinum that enters into its construction. The calorimetric shell recently presented to the Society of Encouragement by Mr. Mahler is a modification of the Berthelot apparatus, designed to put into the hands of engineers an apparatus which is relatively cheap, a true coal tester, which shall permit them to easily estimate the value of solid, liquid and gaseous fuels with all the exactness of a scientific process. Before describing this new apparatus, we shall recall the principle of the calorimetric bomb. The combustible is placed in a vessel with resistant sides, then oxygen is introduced under a proper pressure, and the vessel is tightly closed. If the apparatus be afterward immersed in the water of a calorimeter, and the combustible be fired by any artifice whatever, the latter, owing to the great quantity of oxygen, will burn completely and almost instantaneously. Its disengaged heat will then be transmitted, without any loss, to the water of the calorimeter and to the various parts of the apparatus, and it will be easy to estimate it, as in all calorimetric operations. Only, in the present case, seeing the rapidity of the experiment, the majority of the corrections in use in cabinets of physics need not be taken into account, for example, those due to the evaporation of the water.



MAHLER'S CALORIMETRIC SHELL.

B. Steel shell. G, K, S. Helicoidal agitator. A. Insulating jacket. T. Thermometer. P. Bichromate battery. O. Oxygen tube. M. Manometer. C. Capsule in which the combustible is placed. E, F. Electrodes.

The combustible is fired by putting it in contact with a spiral of iron that an electric current burns at the desired moment. The complete experiment, with the time necessary for preparation, requires three quarters of an hour.

The calorimetric shell consists of the following parts:

(1) The shell is of superior soft steel, forged on a mandrel. Its sides are $\frac{3}{16}$ inch in thickness, and it has a capacity of 39 cubic inches. It is nickel plated externally, and is protected internally against the corrosive action of the nitric acid which always forms during combustion by a lining of enamel. This enamel lining, which is necessary for the preservation of the

apparatus, replaces the several thousands of dollars' worth of platinum that lines the apparatus of the College of France. The shell is closed with a screw plug which compresses a leaden washer. This plug carries a cock with a conical screw which serves for the introduction of the oxygen. It is traversed by a well insulated electrode, which is prolonged to the interior by a platinum rod. Another platinum rod, likewise fixed to the plug, supports the flat capsule in which the combustible is placed. The figure to the right clearly shows these details. The artist has not forgotten the little iron wire that performs the role of a primer.

(2) The other parts of the apparatus are the calorimeter, the insulating jacket and the agitator. They differ in details that make the net cost less than that of those in use in Mr. Berthelot's laboratory. Mr. Berthelot's helicoidal agitator is actuated by a very simple kinematic combination which allows the operator to give the system a regular motion without fatigue.

(3) We must also mention the thermometer which indicates the hundredths of a degree, the generator of electricity (a 10-volt bichromate battery), and the minute counter (watch or sand glass).

The oxygen necessary for the experiment is derived from a tube furnished by the Continental Oxygen Company. As the pressure necessary for the combustion of 15 grains of coal is 25 atmospheres at the most, and as the cylinder contains 120 atmospheres, we thus have a supply for nearly a hundred experiments.

The apparatus gives the calorific power of solid combustibles, such as coal, or of liquid ones, such as mineral oils. It serves also for determining the calorific power of different gases, in which case a vacuum is formed in the shell, and the latter is filled for the first time with gas. Then a vacuum is formed again, and the gas under the barometric pressure and at the temperature of the laboratory is definitively introduced. The oxygen is then added, and we proceed as with solids and liquids.

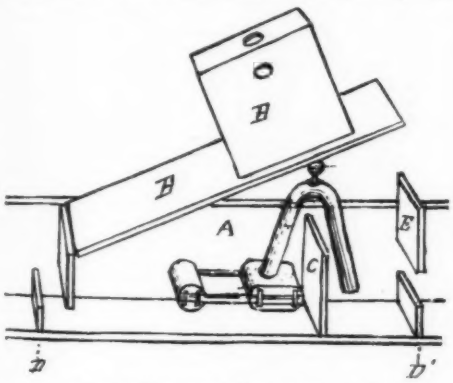
The determination of the calorific power of gases offers a peculiar difficulty. It is necessary to take the precaution to dilute the gas in such a quantity of oxygen that the mixture shall cease to be combustible. For illuminating gas, 5 atmospheres of oxygen suffice. For that of industrial gas generators, half an atmosphere is not exceeded.

The apparatus, which has been presented to the Society of Encouragement, has already served Mr. Mahler for effecting 400 combustions. Its precision leaves nothing to be desired. It is so easily manipulated that any laboratory boy, provided he is careful, can obtain accurate results from it.—*La Nature.*

DECKER'S SIPHON MODULE.

By H. C. HOVEY.

WHILE attending the irrigation convention at Las Vegas, N. M., I was greatly interested in an invention that seems to solve a difficulty that has always been



DECKER'S SIPHON MODULE.

serious where a number of parties draw their supplies of water from a common reservoir. Those who have given the matter attention know that it is one thing to measure accurately a stream of pure water flowing with a degree of regularity and quite another to measure a stream of ditch water carrying more or less sediment, and flowing at times like a torrent and at other times dwindling to a mere rill. Delicate meters are sure to be clogged and need constant watching; and the old style of weirs needs to be reset with every rise or fall of the stream. This question of water measure was deemed so important as to receive much attention at the last meeting of the American Society of Civil Engineers, at Chattanooga, where they spent an entire day in discussing the various methods that had been invented or suggested up to that time. Hence the writer feels that he is rendering a service to the public in describing the new siphon module exhibited by Mr. H. L. Decker at Las Vegas. Hundreds of practical men, from all parts of the Southwest, saw the working model, constructed on a scale to irrigate fifty acres, and the unanimous verdict was that it met the conditions perfectly.

Omitting technicalities, we may say that the device is simply a metallic siphon of any suitable size, attached to a float and balanced by a second float connected with it by arms, the whole being inclosed in a box capable of being securely fastened to prevent tampering by dishonest interference. The only thing that can be controlled by the consumer is the flood gate, by which he can, if desired, decrease the flow but not increase it. The box is so constructed as to prevent the flow from leaving the siphon in case of temporary closing, or of any accident happening to the ditch. A glass globe, filled with water, is placed on top of the siphon, to receive the air that the siphon may collect while in operation, which is observed by the man in charge of the ditch. This may have to be refilled once or twice during the season. Otherwise the machine works automatically. To make the matter more clear we refer to the accompanying cut. A is the box or flume, placed within the banks of the ditch; B is the cover or lid, with apertures for observation; C is the dividing board over which the siphon lifts the water; D and D' are boards placed at each end of the box, their tops being on a level with the bottom of the ditch, thereby receiving the minimum flow and retaining it in the vats thus made, and where the ends of the siphon constantly rest. As long as there is enough water to supply each siphon with its full share, they will discharge in the air for distribution. But if there should be at any time a deficient supply, the discharge end of the siphon sinks into the lower vat, thereby reducing its head; and all the siphons in the system being placed alike, they will sink uniformly and thus reduce the flow equally, giving each consumer his due proportion, until the water supply is wholly exhausted. It should be added that, at the beginning of the season, the siphon is started by means of an air pump, after which it needs no further attention until its flow is stopped, with the exceptions already mentioned, but the air pump will not have to be used again till the beginning of another season.

To illustrate the practical working of this ingenious device, we may suppose one hundred farmers to draw their water supply from a common reservoir. The diameter of each siphon will be according to each consumer's water rights. This is determined at the outset by experiment, and the siphon selected accordingly. Should it be found desirable, in the course of the season, for any individual to reduce the flow through his siphon, or to shut off the supply altogether, this can be done by means of the flood gate, E, which can be lifted again at pleasure. Should the general water supply get low, each consumer would still draw his fair proportion till the supply was entirely exhausted.

APPARATUS FOR REMOVING VEGETABLE MATTER FROM WOOL.

THIS is an invention by Ludwig Kern, of Hamburg, Germany. *a* is a closed chamber, in which the textile goods. *b*, to be treated are stirred up by an agitator. *c*, to which motive power is imparted by means of a pulley, *f*, mounted on the shaft, *d*, of the agitator. At the bottom of this chamber is placed a perforated serpentine tube, *g*, which communicates through the medium of the pipe, *g'*, with the retort, *h*, of a gas generator, *i*. Through a siphon, *k*, hydrochloric acid or any other mineral acid is conducted into the retort, *h*, and there gasified or vaporized by means of heat. The developed gases or vapors when led through the pipe, *g'*, into the coil, *g*, are equally distributed by the perforations of the latter in the chamber, *a*, where they will act, for instance, to carbonize or destroy the vegetable fibers carried with the woolen textile goods to be treated. From the chamber, *a*, two pipes, *l* and *m*, are led to a proportionally high absorbing vessel or condenser, *p*, being provided with a perforated bottom, *p'*, upon which is placed a layer of coke or other porous material, *q*, and with an atomizer, *r*, serving to produce a very fine spray of water or an aqueous solution of a substance capable of chemically combining with the gases escaping from the chamber, *a*. The pipe, *l*, emits directly above the heaped material in the carbonizing chamber, *a*, while the mouth of the pipe, *m*, is arranged at the top of the chamber.

Fig. 1.

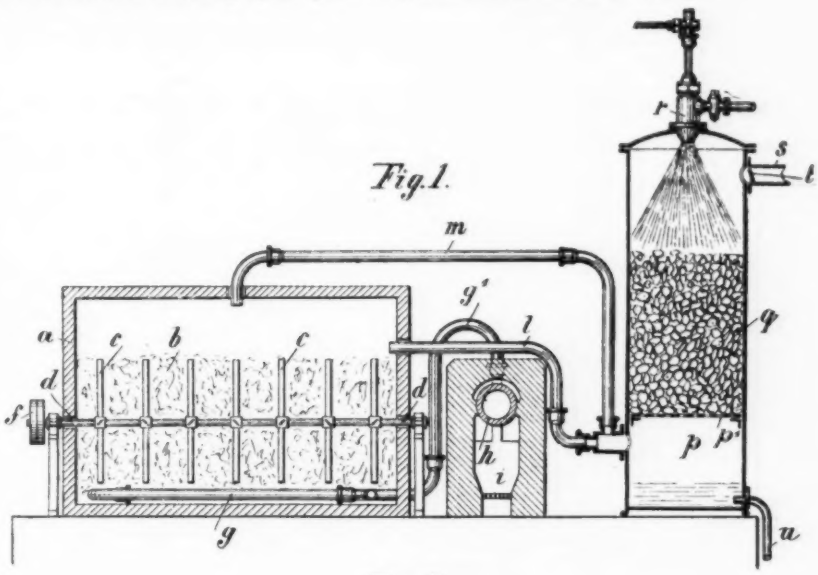
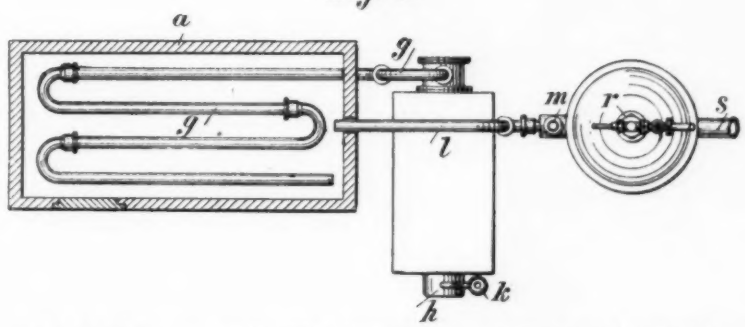


Fig. 2.



APPARATUS FOR REMOVING VEGETABLE MATTER FROM WOOL.

The operation of the apparatus will be as follows: The heated vapors or gases developed in the retort, *h*, when first entering the chamber, *a*, displace the air inclosed in the latter and in the absorbing vessel, *p*, so that it may escape through the exhaust pipe, *s*, into a chimney or be drawn off by means of an exhauster. In the exhaust pipe, *s*, is preferably placed a valve, *t*, in such a manner that it will only permit the escape of the air or gases from the vessel, *p*, and prevent the entering of the same from outside. As soon as the air is discharged the atomizer, *r*, is set in action, so that the spray of water or other absorbing liquid is distributed over the layer of coke, *q*, or the like piled on the perforated bottom, *p'*, in the vessel, *p*. Hereby a large surface is exposed to contact with the vapors or gases escaping from the chamber, *a*, through the pipe, *m*, so that the same will be not only condensed, but also absorbed, in the vessel, *p*, by the liquid distributed through the atomizer, *r*, so that a partial vacuum is established in the condenser, *p*, which will exert a considerable sucking action upon the gases in the chamber *a*, and cause the carbonized dust-like particles or impurities of the woolen textile material stirred up by the agitator, *c*, to discharge through the pipe, *l*, into the lower part of the vessel, *p*, where they will settle and be conveyed away through the pipe, *u*, with the absorption liquid combined with the noxious gases. If only the bleaching of textile piece goods or fibers is intended, the agitator in the chamber, *a*, may be entirely abandoned and the retort replaced by any other generator of chlorine or other gas.

CONTINUOUS DISTILLATION APPARATUS FOR WINE.

As the consumption of brandy gradually becomes more general, and the idea that genuine good Cognac can only be made in France disappears, the distillation of wine becomes of ever-increasing importance for the wine-producing districts.

Although in certain cases the best and finest brandy can be produced with the simple distillation apparatus, and especially when fractional distillation is necessary only such simple apparatus can be applied, yet with wines which yield a fine distillate of good taste at the first distillation, it is of great advantage to make use of continuous distilling apparatus.

This is also well adapted for use in the production of spirits of wine from wine, and of brandy from diseased wines, a crude spirit being produced by the first distillation, from which a good brandy can subsequently be obtained by fractional distillation.

Continuous apparatus of this nature are very superior to the simple distillation plant, and enable a considerable economy of time, work and fuel to be effected, since they can be used without cessation for a long period, and the wine to be distilled is used for cooling the distillate, and is thus itself heated before its arrival in the retort. Such an apparatus is exhibited in the Agricultural Exhibition at Vienna by Messrs. Egrot, of Paris.

The wine to be distilled is kept in a reservoir which is situated above the level of the distilling apparatus. It is first allowed to flow from the reservoir into a condenser. The wine here becomes hot, after which it passes to the distilling column, which contains a series of plates fitted internally with specially constructed tubes. In passing over these plates the wine is freed from alcohol and passes into a retort heated by a separate furnace and from which the wine is siphoned as soon as it collects. The non-spirituous liquor arriving in the retort gives off a vapor which rises into the internal pipes contained in the plates of the distilling column, thus effecting the distillation of the wine contained in the column. The alcohol vapor thus produced passes to a dephlegmator where the watery portions are condensed, and the portions rich in alcohol pass on into a condensing worm, where they condense and are collected. To completely exhaust a wine, one plate is required for every two per cent. of

alcohol in the wine. The distillate can be obtained of any strength from 65—85 , and by means of a rectifier to be placed on the dephlegmator, 90 can be reached. Once the process has been started, it is only necessary to see that a continuous supply of wine is kept up, and that a steady fire is maintained, in order to obtain a distillate of constant strength throughout a whole day without interruption. The apparatus is made of various sizes, capable of distilling from 400—100,000 liters of wine in the twenty-four hours.—*Land und Forstwirth Anst. Zeit.*

ELECTRICAL STOCK QUOTATIONS.

THE following are the latest prices for electrical securities in New York, as quoted by George B. Ellery, financial editor *Electrical Age:*

Names of Companies.	*Capital.*	*Par.*	*Price.*
Aluminum Co	$350,000	$100 00	$90 00
American Dist. Tel., N.Y	3,825,000	100 00	62 00
Am. Elec. Exercise Mach. Co., N.Y.	100,000	10 00	9 00
Am. Carbon' Ins. Mfg. Co., Boston.	620,000	5 00	2 50
American Electric Motor Co., N.Y.	1,000,000	25 00	5 00
American Engineering Co., N.Y	1,000,000	100 00	60 00
American Telegraph and Cable	14,000,000	100 00	82 00
American Telephone Co., D. C	100,000		*101
Ashley Engineering Co	200,000	10 00	6 00
Aut. Phon. Exb. Co., N. J	25,000	100 00	*20 00
B. & S. Elec. Equipment Co., N.Y.	25,000	100 00	100 00
Barr Electric Mfg. Co., N.Y	50,000	100 00	100 00
Bay Electric Co. 6s, Mich	25,000		*101
Bell Telephone	15,000,000	100 00	205 50
Bell Telephone 7s	2,000,000		*113
Boston Electric Light Co	1,500,000	100 00	168 00
Brooklyn Edison Electric Light	1,500,000	100 00	75 00
Brooklyn Citizens' Electric Light	500,000	100 00	140 00
Brooklyn Municipal Light	500,000	10 00	14 50
Brunswick Elec. L. & P., Me	50,000	100 00	100 00
Brush Elec. Light Co., Baltimore	650,000	100 00	
Brush Elec. Lt. Co. pref., Balto	600,000	100 00	80 00
Brush Elec. Lt. Co., Balto., 5s	300,000		*105
Brush Elec. Co., Cleveland, pref	1,000,000	50 00	37 50
Brush Elec. Ill., N.Y	1,000,000	100 00	30 00
Brush Elec. Ill., 6s, N.Y	300,000	100 00	*102
Brush-Swan E. L. Co. of N. E	2,000,000	100 00	20 00
Bucksport Elec. Co. 6s., Me	20,000		*102
Burrell Electric Signal Co., N.Y	500,000	20 00	10 00
Circleville, O., L. & P. Co. 6s	20,000		*95
Circleville, O., L. & P. Co	100,000	100 00	98 00
City of London Elec. Lt. Co., Ltd	4,000,000	50 00	30 00
Commercial Cable Co	7,716,000	100 00	157 00
Complete Elec. Con. Co., N.Y	50,000	100 00	175 00
Cons. Electric Light Co., N.Y	2,500,000	100 00	50 00
Cons. Elec. Storage Co., N.Y	3,000,000	25 00	4 00
Cons. Gas Co., N.Y	35,430,000	100 00	112 25
Con. Gas. & E. Co., Batavia, 6s	80,000		*95
Cons. Subway Co., N.Y	3,000,000	100 00	25 00
Darlington L. & W., 5s, S. C	15,000		*99
Desant Elec. and Sig. Co., N.Y	100,000	100 00	110 00
Detroit Elec. Lt. & P. Co	300,000	25 00	15 00
Detroit Elec. Lt. & P. Co. 6s	300,000		*101
Detroit Electrical Works	1,000,000	10 00	8 00
Direct U. S. Cable Co., Ltd	6,400,000	100 00	50 00
East River E. L. Co. 6s	600,000		par
East River Electric Light Co	1,000,000	100 00	40 00
Easton Elec. Co., N.Y	1,000,000	100 00	20 00
Economic Lt. & P. Co., S. C	100,000	100 00	100 00
Edison Electric Co	50,000,000	100 00	100 00
Edison Elec. Ill. 5s, N.Y	2,500,000		*102
Edison Elec. Ill., Lebanon, Pa	80,000	10 00	13 75
Edison Illuminating, N.Y	4,500,000	100 00	81 00
Edison Elec. Lt. Co., Phila	1,000,000	100 00	80 00
Edison General	15,000,000	100 00	92 75
Edison General Receipts		100 00	97 50
Elec. Sup. & Con. Co., N.Y	120,000	15 00	16 00
Elizabeth E. L. Co., N. J	100,000	10 00	4 50
Elmira Municip. Imp. Co., 5s	1,800,000		par
Erie Telephone	4,800,000	100 00	46 00
Excelsior Electric Co. 6s, N.Y	300,000		par
Fargo Gas & Elec. Co. 6s, Dak	100,000		*92
Fidelity Trust Receipts	25,000,000		75 50
Florence Im. & Mf. Co., 6s, S. C	15,000	100 00	*98
Fort Wayne Electric Co	4,000,000	25 00	13 00
Franklin Electric Co., N. Y	5,000,000	100 00	*83 00
Fremont E. L. & P. & Gas. Co., O	95,000	100 00	102 50
G. T. Woods Mfg. Co., Ky	2,000,000	10 00	2 50
Gloucester Elec. Co., Mass	20,000	20 00	19 00
Great Western Elec. Sup. Co	650,000	10 00	9 00
Gt. West. Elec. Sup. Co. pref. 8s	350,000	10 00	10 00
Guarantee Identification Co., N.Y.	50,000	50 00	51 00
Hackettstown Elec. Light, N. J	25,000	20 00	30 00
Harlem Elec. Light Co	250,000	100 00	20 00
Hickory Electric Co., N. C	12,000	100 00	105 00
Hoboken Land & Imp. 6s	1,000,000		*100
Hunt Engineering Co., N.Y., 6s	30,000	100 00	*95
Hunt Engineering Co., N.Y	30,000	100 00	105 00
Interior Conduit & Ins. Co., N.Y	1,000,000	100 00	75 00
Int. Okonite Limited	1,700,000	50 00	49 00
Jamaica Gas & Elec. Light, N.Y	60,000	100 00	80 00
Kankakee Elec. Co. 6s, Ill	50,000		*95
Kansas Electric Co. 6s, Mo	20,000		*96
Laclede Gas Co	7,500,000	100 00	18 00
Laclede Gas pref	2,500,000	100 00	57 50
Laclede Gas 5s	10,000,000		*81
Law Telephone	400,000	100 00	96 00
Lincoln E. L. & P. Co., Ill., 5s	50,000		*94
Little Rock Edison E. L. & P. 6s	30,000		*95
Livingston E. Lt. Co., Mont. 6s	30,000		*92
Long Branch Electric Light	50,000	100 00	70 00
Manhattan E. L. Co. Ltd 5s, N.Y	1,000,000		*90
Marshalltown Elec. Co. 6s, Iowa	65,000		*98
Marysville L. & W. Co. 6s, Ohio	60,000		*104
McLeod Car Heat. & Vent. Co	1,000,000	25 00	35 00
Metropolitan Phonograph	22,500	100 00	*20 00
Metropolitan T. & T. Co., N.Y	3,500,000	100 00	100 00
Metropolitan T. & T., 5s	2,000,000		*105
Montclair Elec. Lt. Co., Denver	50,000	100 00	94 00
Montclair E. Lt. Co., Denver, 8s	20,000		*107
Mount Morris 5s, N.Y	2,300,000		*90
Mount Morris Elec. Lt., N.Y	1,000,000	100 00	30 00
Morristown L. H. & P. 5s, N. J	30,000		*102
Morristown L. H. & P	50,000	100 00	101 00
Muncie-Coles Electric Railway Equipment Co., N.Y	500,000	100 00	101 00
Nat'l Aut. Fire Alarm, L. I	150,000	100 00	100 00
National Elec. Manuf. and Const. Co., N.Y	50,000	100 00	101 00
National Lead Trust	9,000,000	100 00	19 50
New England Butt Co	100,000	1,000 00	1,000 00
New England Phonograph Co	12,500	100 00	*20 00
N. E. Tel. & Tel. Co	10,384,600	100 00	51 50
N. Y. and N. J. Tel. and Tel. 5s	1,500,000		*90
N. Y. and N. J. Telephone Stock	2,555,000	100 00	94 00
N. Y. Phonograph Co	20,000	100 00	20 00
Newark L. & P	150,000	100 00	58 00
Newark E. L. & P. Co. 6s, Ohio	50,000		*98
North American Railway Co	20,767,300	100 00	14 25
North New York Lighting	150,000	100 00	10 50
Northwest Elec. Co. 6s, Manitoba	50,000		*95
Postal Telegraph	10,000,000	100 00	37 00
Pennock Baty. E. L. & Impt. Co., Ill	500,000	1 00	3 00
People's Elec. Light, Trenton	100,000	100 00	90 00
Pettingell Andrews Co., Boston	300,000	25 00	30 00
Pittsburg Reduct. Co., Aluminum	1,000,000	100 00	105 00
Plainfield Electric Light	100,000	100 00	75 00
Public Works Imp. Co., Tenn	500,000	100 00	75 00
Public Works Imp. Co., Tenn., 6s	500,000		*90
Richmond L. H. & P., S. I	150,000	100 00	
Richmond L. H. & P. 5s	150,000		*95
Rockaway Elec. Light	50,000	100 00	50 00
Rockaway Elec. Lt. Co. 6s	75,000		*95
Russell Electric Co., Boston	300,000	5 00	5 00
Saginaw E. L. & P. Co. 6s, Mich	50,000		*95
San Diego Gas & Elec. Co. 6s, Cal	750,000		*90
Sawyer-Man Elec. Light Co., N.Y	125,000	100 00	100 00
Shaver Corporation, N.Y	100,000	1 00	8 00
Short Elec. Ry. Co., Cleveland, O	5,000,000	10 00	8 00
Sprague Elec. Motor Co	16,000	100 00	*80 00
Swan Incandescent	800,000	100 00	6 00
Standard Ug'd Cable Co., N.Y	1,000,000	100 00	80 00
Staten Island L. H. & P. Co	100,000	100 00	95 00
Stuttgart Imp. Co. 6s, Ark	50,000		*90
The Gamewell Fire Alarm Tel. Co.	750,000	100 00	100 00
The Hall Signal Co., N.Y	800,000	100 00	100 00
The Hall Signal Co. pref., N.Y	$100,000	$100 00	$105 00
The Ongley Electric Co., N.Y	250,000	100 00	85 00
Railway Impt. Co., N.Y	10,000,000	100 00	100 00
The Siemens & Halske Co., Ill	500,000	100 00	par
The Washington Wat. Pow., Wash.	1,500,000	100 00	80
The Wells & French Co., Ill	600,000	100 00	par
Thomson-Houston Electric Co	6,000,000	25 00	58 50
Thomson-Houston pref	4,000,000	25 00	28 75
T.-H. Electric Co. 5s, Boston	500,000		*100
T.-H. E. L. Co., Yonkers, 6s	100,000		*99
T.-H. L. H. & P. Co., Binghamton 6s	100,000		*99
Tucker Elec. Const. Co., N. Y	50,000	100 00	100 00
United Elec. Light and Power	3,000,000	100 00	40 00
United States Elec. Co	1,500,000	100 00	25 00
United States Illuminating, N.Y	1,250,000	100 00	30 00
Universal Arc Lamp Co	100,000	100 00	
Western Union	86,188,852	100 00	87 50
Westinghouse Elec. & Manf. Co	7,000,000	50 00	30 50
Westinghouse Elec. Co. pref. 7s	4,000,000	50 00	45 00
Westinghouse Ass. Rects		50 00	18 00
West Point W. Lt. & P. Co., Va	25,000	100 00	100 00

* Per cent. † Registered stock.

[FROM THE ELECTRICAL ENGINEER.]

DYNAMIC INDUCTION AT HIGH POTENTIALS AND FREQUENCIES.

By ELIHU THOMSON.

IT is the purpose of the present writing to supplement the experiments which were described by me a short time since, in which condenser discharges at comparatively high potentials were used to induce by dynamic induction similar discharges in parallel circuits or coils. The application of the principle to the production of an efficient lightning protector or device affording a selective path for high frequency discharges has already been pointed out. So also the effects of the use of varying numbers of turns in the coils under induction have been shown; effects which have enabled me up to the present to obtain sparks of over 51 inches in length in free air between ball terminals about one inch in diameter and in an apparently continuous stream of not less than 250 per second. These sparks are bluish white, like Leyden jar discharges, and are accompanied by a loud rattle or roar. These effects and their bearing on insulation will be further adverted to.

The following experiment is an exceedingly instructive one, as showing the means I use for obtaining a balance of E.M.F.'S. or selective path: Two coils of heavy wire are wound, each having about 12 to 15 turns, more or less. The coils are separated by a glass cylinder, one coil being in the interior of the cylinder and the other being wound outside thereof. Connections are made as in Fig. 1. The turns of the coils should be kept apart, or well insulated from one another. An incandescent lamp, L, is put in circuit with one of the coils, as the outer one, by putting one terminal of the lamp in connection with one end of the inner coil and the other lamp terminal to one end of the outer coil. The wires, *a b*, permit condenser discharges to be passed through the inner coil; a branch wire, C, is taken from *b* and its free end can be connected to any part of the outer coil so as to include more or less of the turns of the outer coil in a branch with the lamp around the inner one. With say 12 turns in the inner coil, and a possible change of the turns of the outer coil from none to 15 or 16, and passing condenser discharges over an air gap at J, with an air blast playing on the spark to prevent continuous arcs, when the condenser charges are furnished by the high potential secondary of an alternating current transformer, the lamp at L would be lighted to a greater or less brilliancy according to the turns of the outer coil in use. In applying the movable wire to the outer coil at a certain point, there is found to be no current passing in the lamp, and on passing this wire either way from this point so as to include more or less of the outer turns, the lamp is lighted with gradually increased brilliancy as the neutral point is more and more departed from. Of course a current indicator, provided it responds to currents of excessive frequency, may be substituted for the lamp. This experiment shows in the clearest manner the fact that a selective path for the discharges of high potential is obtained in adjusting the relative number of turns in the outer and inner coils.

I have in a previous communication stated in what way this combination of inductive coils has been applied as a lightning arrester or protective apparatus for dynamos, motors, transformers, etc. Varying the spark length at J, or the condenser capacity, does not, so far as has yet been determined, disturb the relations found. It is, of course, necessary that the two coils be well insulated from each other, and this can easily be done by immersion in oil or separating them by glass, hard rubber, or the like.

Fig. 1.

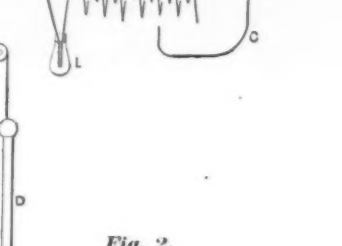


Fig. 2.

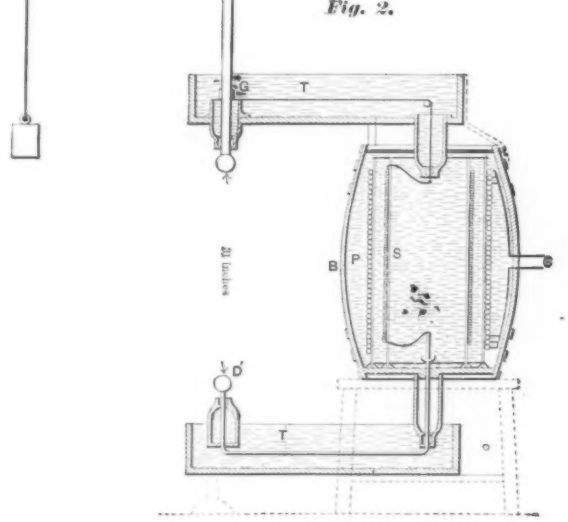
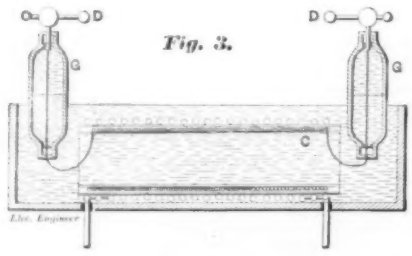


Fig. 3.



I will now describe certain forms of apparatus which are adapted for obtaining, at will, very high potential discharges. In fact, I have been able easily to obtain, from about 1,600 feet of wire, sparks of over 31 in. between the discharge balls. So far as can be estimated from available data, these sparks are due to potentials of not less than half a million volts.

In Fig. 2, B is a barrel of lubricating oil, an oil of high insulating qualities, being in fact a liquid paraffine. The top of B is open, and in it are immersed the primary and secondary coils, P and S, each wound on a paper cylinder. The cylinder on which S is wound is about 3 in. smaller in diameter than the other and has an external diameter of about 13 in. It is covered with two layers of silk, and upon this is wound 500 turns of No. 26 cotton-covered wire in one layer, with a silk thread between the turns. This layer covers about 20 in. of the length of the cylinder. The terminals of this fine coil are carried out respectively through the lower head and up through the oil above, as will be described.

The primary, P, consists of fifteen turns of a conductor composed of five rather heavy wires laid alongside, and the connections are made by carrying the terminals outside at C, keeping them about two inches apart. The wire leaving S downward goes to a rod which rests in a cup in the center of the bottom head of the barrel. This cup has a rod extending down through a glass cylinder filled with oil which dips in a horizontal

trough of oil, T, through the center of which is carried a prolongation of this rod to conduct the discharges to the lower discharge terminal, D.

The upper end of S is treated in a similar way, passing up through a cork in a glass vessel, such as an inverted bottle with the bottom perforated, then horizontally in the trough, T, of oil to the sleeve, G, through which a hollow brass bar, D, with rounded ends, may be slid up and down. For this purpose a string and pulley with counterweight, W, may be provided. The bar, D, should be say an inch in diameter, to avoid brush discharges from its sides, and, in fact, its upper end should be covered with a bottle of oil or have a large polished ball; otherwise large brush discharges will pass into the air from it. By means of a condenser and spark gap with a blast of air blowing across the gap, the apparatus may be used to obtain the high potential and high frequency sparks. The charging of the condenser is from the secondary of a high potential induction coil given about 15,000 to 20,000 volts, the primary of which coil is fed from alternating current mains. The condenser used in the experiments consisted of 16 Leyden jars of about a gallon each, which was all there was at command. This will be replaced by a special condenser adapted for such work. The discharges from the apparatus are, as stated, over 31 in. long, and this distance is the maximum that can be given to the space between the terminals as the apparatus is constructed. Fig. 5 shows the actual apparatus.

The power of the discharge is exemplified by the ease with which glass plates are punctured. Heavy pine or even oak boards are perforated and set on fire. The discharges scorch a black line where they pass over a surface of wood, and soften glass where they locate themselves in passing over a sheet. A stick of wood placed between the terminals and joining them is splintered and torn by the discharge, and is found covered with a fur of fine splinters. Glass vessels are shattered in the line of the discharges, and inflammable matter is set on fire. Perhaps the most beautiful effect is obtained by the insertion of a plate of glass between the electrodes when separated about 24 inches. If the glass be thick enough to resist perforation, the discharges spread all over it and pass around the edges, producing an almost indescribably beautiful effect, especially in a feebly lighted room which allows all the minor ramifications of sparks to be seen.

The induction in the fine secondary of the apparatus is about 1,500 to 2,000 volts for each turn, which would give 750,000 to 1,000,000 volts total for the 500 turns. But on account of condenser actions absorbing a part of the discharge, it is probable that the effective electromotive force between the terminals may not much exceed 500,000. We have no ready means of measurement of such pressures. A very simple and inexpensive form of apparatus for obtaining these high potential discharges is shown in Fig. 3. It consists of a wooden trough, the joints of which are capable of holding oil; its parts may be nailed or screwed together in the ordinary way with shellac or white lead.

The primary coil of ten turns lies against the sides of this trough, and the secondary layer may be an ordinary wire heavily insulated with cotton and wound on a cylinder of paper, C, or cardboard covered with dry muslin or silk. If the turns are not over six inches in diameter, the cotton insulation between turns will suffice, if rather thick, say $\frac{1}{10}$ of an inch or over.

The secondary terminals are taken out at the center of the ends of the cylinder, as shown, and led up through a glass vessel, G, which may be conveniently made of two bottles with the bottoms removed and cemented together; or a specially blown glass vessel may be used instead. Its object is to hold oil and cover the secondary terminals to a height sufficient to remove them far enough to prevent discharges passing over the surface of the oil in the trough which is used to cover the coils, as indicated. The discharge terminals, D D, pass up and outward from the bottles and the sparks are obtained between them. The simplicity of construction is evident. A trough four feet long will hold a coil capable of giving a spark discharge three feet long. By coupling up two such troughs in tension this effect may doubtless be doubled, if required.

It is important, of course, that all connections, leads from the condenser to the primary coil, etc., be as short and as free from self-induction as possible, or the rate of oscillations on which the high inductions depend will be lessened and the effects be weakened to some extent. The potential given by a secondary coil of a certain number of turns depends, of course, on the rapidity of magnetic change and the extent of such change, or maximum densities of field attained. The greater the number of turns in the primary, the greater will be the field strength if the same current flows in every case. But increasing the number of primary turns slows the oscillation rate and diminishes the maximum current value and so diminishes the magnetic density. There is evidently to be selected, therefore, for each condenser, that number of turns which will give the highest product of the rate of change and the extent of change or maximum field.

As a striking illustration of the slowing effect of numerous turns of wires on the periodicity or rate of change, it may be mentioned that if, instead of passing the condenser discharges through a coarse coil of few turns, using the spark gap and charging transformer as before, they be passed through a well insulated coil of many turns of comparatively fine wire, the discharge rate may easily be brought down low enough to cause the spark to whistle along with the sound of the alternating discharges of 125 periodicity used in the charging transformer. The introduction of a well made iron wire core greatly lowers the tone obtained. It is conceivable that an approximation to music might be obtained from spark discharges sent through coils of such varied inductance as to cause the rates of oscillation to follow those of the musical scale.

In the conduct of the experiments on high inductions which have been described, one cannot fail to be impressed with the capabilities of oil as an insulator. The perforation of two inches of oil between rounded terminals of say ½ in. diameter would seem to demand a potential capable of causing a leap of five feet in air.

It appears to be true that edges or points under oil or embedded in any insulating medium are effective in inducing puncture for the same reasons as they are effective in discharging through air. They act as electric wedges and concentrate the dielectric strains upon those parts of the insulating medium directly in front of such points or edges. Hence the most perfect insulation to resist puncture in oil or air demands smooth surfaces of as large diameter as possible. This is, of course, a different matter from insulation resistance or power of resisting leakage.

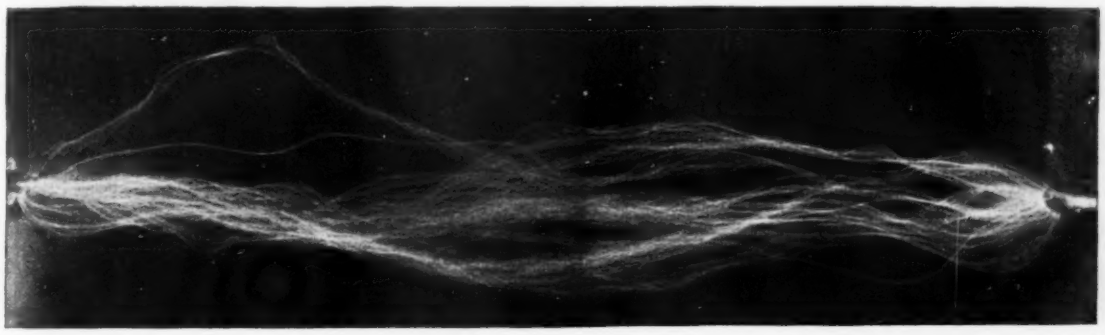


FIG. 4.—DYNAMIC INDUCTION DISCHARGE THROUGH 30 INCHES OF AIR, AT 500,000 VOLTS.

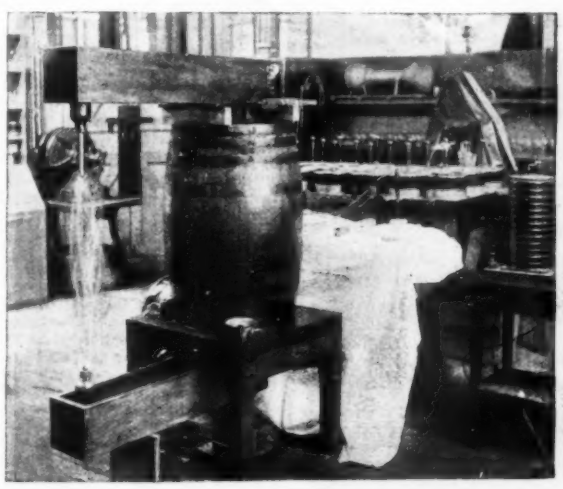


FIG. 5.—APPARATUS FOR HIGH POTENTIAL DISCHARGES.

MEDICATED SKIN VARNISHES.

SKIN varnish is the term applied by Unna to preparations used in dermatological practice for forming a thin covering on the skin. The principal bases for these preparations are the following:

Bassorin Varnish.—The pure bassorin basis is obtained, according to Elliot, by filtering tragacanth mucilage (15:100) in a filter heated by steam, evaporating and mixing with glycerin. A similar basis may be prepared by stirring five parts powdered salep with 95 parts cold water until a smooth mucilage is obtained, then heating for half an hour on the steam bath. The salep basis contains less bassorin but more starch.

Casein Varnish.—The casein obtained by coagulating skim milk with rennet at a temperature of 35° to 40° is washed and dried until it forms a yellowish white sandy powder soluble in alkaline solutions. In preparing the casein varnish this casein is dissolved by means of borax. For 20 parts casein, 2·5 parts of borax and 77·5 parts water furnish a rapidly drying uniform covering material. The alkaline characters of the borax are marked by the casein. Admixtures of heavy pulverulent substances readily settle out of this basis and it is requisite to distribute them by shaking. A varnish of casein and glycerin is prepared by dissolving the casein in 3 or 3·5 parts of ammonia, adding a quantity of glycerin equal in weight to the casein, and heating to drive off the ammonia. The resulting mass mixed with twice its weight of boiling water gives an excellent permanent emulsion.

Amber Varnish is made by dissolving a mixture of amber and turpentine in alcohol. It must not be used as a vehicle for the application of zinc oxide.

Castor Oil and Shellac Varnish.—With 1 part shellac, ½ part castor oil, and 3 parts alcohol, a varnish is obtained which forms a good flexible covering easily removed by alcohol.

Canada Balsam and Collodion Varnish.—Sixteen parts collodion with 1 part Canada balsam gives a material suitable for the application of pyrogallol, and it can be easily removed by alcohol.

Castor Oil and Collodion Varnish.—Eight parts collodion and one part castor oil.

Lead Ricinoleate Varnish.—One part lead oxide heated with 1·5 part castor oil to saponification and mixed with two parts absolute alcohol gives a good skin varnish.

Chrysarobin Amber Varnish.—One part chrysarobin and 20 parts of amber dissolved in turpentine.

Pyrogallol Shellac Varnish.—One part pyrogallol, 1 part castor oil, 5 parts shellac and 15 parts absolute alcohol.

Salicylic Acid, Canada Balsam and Collodion Varnish.—One part Canada balsam, 10 parts collodion and 3 parts salicylic acid.

Zinc Oxide, Castor Oil, and Collodion Varnish.—Two parts zinc oxide, 2 parts castor oil and 16 parts collodion.

Zinc and Lead Ricinoleate Varnish.—Five parts lead ricinoleate, 8 parts zinc oxide, 8 parts absolute alcohol, and lastly 1 part each of collodion and ether.

Ichthyol Borax Casein Varnish.—Five parts sodium ichthyolate and 15 parts borax casein varnish.

Sulphur Glycerin Casein Varnish.—Five parts sulphur and 15 parts glycerin and casein varnish.

Zinc Oxide Salepbassorin Varnish.—Two parts zinc oxide and 18 parts salepbassorin varnish.

Zinc Ichthyol Tragacanth Bassorin Varnish.—One part sodium ichthyolate, 2 parts zinc oxide, and 17 parts tragacanth bassorin varnish.—*Therapeut. Monatsch.; Phar. Jour. and Trans.; Am. Jour. Pharm.*

TROUBLES FROM THE TEETH.

THAT you may more readily comprehend the possibilities of ordinary lesions in the mouth causing more or less serious disturbances in other portions of the economy, a few cases which I have observed and treated are here briefly outlined.

The first is that of a young woman who applied to a surgeon for treatment of a fistulous opening under the chin, from which a moderate but constant discharge of pus flowed. Suspecting alveolar abscess, the surgeon referred her to a dentist, who returned a negative report. The lower ridge of the maxillary was then drilled and scraped, which apparently effected a cure; but in a few weeks the fistula again appeared, and was treated by a second and more heroic drilling. In two months the fistula reappeared, close beside the ugly scar of the first. Another dentist was then consulted, and he readily detected, with an electric lamp, a dead pulp in an inferior incisor. The tooth was then drilled into, the canal cleansed, disinfected, and filled, and although that was four years ago, there has been no return of the fistula.

This case is typical of a considerable class due to devitalized pulps, where the abscess selects a distant part of the body as an outlet or drainage point. I have seen fistulas from this cause opening far down upon the neck or upon the back or breast, and have known them to be treated for years before a dentist discovered the offender, much to the surprise of the surgeon. They

have in more than one instance caused suspicion of abscessed lung, liver, etc.

Another case illustrates reflex irritation through the sympathetic nervous system. After nearly three years' treatment for a persistent rheumatism of the left shoulder, the patient had a left superior molar treated and filled which had been abscessed for several years. Considerable necrosed bone was burred away from about the upper third and for some distance beyond the ends of the roots. Within two days the tooth recovered its former comfortable condition, and with its restoration to health the pain in the shoulder ceased, and the first symptom of its return has yet to be observed, five months since the operation. This same patient had a bridge adjusted in the right side of the mouth, with the posterior end attached to the second molar. The third molar contained a large gold filling on the mesial surface, which came almost in contact with the bridge. Two months later the patient experienced pain and stiffness in the articulation of the inferior maxillary on the right side, with a heavy, dull feeling in the ear on the same side. This continued with considerable severity for twelve hours. Treatment ameliorated the distress, but it was never intermitted for a single day until it was discovered that an electric current had been established between the bridge and the filling, and by electrolysis the pulp had become exposed, causing the symptoms described, by reflex action. The diagnostic test was the placing of an insulator of gutta-percha between the crown and the filling, when the patient was relieved instantly, the entire train of symptoms disappearing at once. I do not wish to be understood as claiming that there was an electrical action between the bridge and the filling, but merely that the introduction of the bridge upon the roots closed the circuit along the nerve tract; whereas, without the bridge, the electrical action was wholly confined to the filling and the decalcified dentine covering the pulp.

The history of dentistry is full of instances of pain reflected to almost every part of the body from affections of the teeth. Thus in a case where the arm was paralyzed, the paralysis disappeared with the treatment of an exposed tooth pulp. In another instance, the removal of a large area of necrosed bone and the restoration of the remaining tissue to normality was followed by the re-establishment of the catamenia, which had been suspended. Another curious case is that of a patient who was confined to his bed for several days with rheumatism involving one entire side of the body. The attack followed a severe toothache, and the pain ceased with the relief of the affection of the tooth.

These are extreme illustrations, but they show how far and in what diverse directions reflexes from the teeth may ramify. The fact that they do occur only serves the more forcibly to emphasize the need of a thorough knowledge on the part of the surgeon of the relations, near and remote, of the oral cavity.

To return to what is more properly our subject—a partial survey of the border land between dentistry and oral surgery—the cause and effects of mouth breathing require a passing notice. Whether mouth breathing is a cause of the irregularities accompanying the high vault and contracted jaw is just now a disputed question, to the clearing up of which Dr. Talbot contributed a valuable paper at the recent meeting of the American Dental Association; but that it does result in deformity or asymmetry of the face there is little room to doubt. Mouth breathing is usually due to obstructions in the nasal passages, the most prolific of these obstructions being found in the upper part of the pharynx, in the shape of adenoid growths. These growths are engendered at all ages, and unless quickly removed, especially in the case of children, irreparable mischief will be wrought. Frequently dentists are consulted by parents with the idea that irregularities of the teeth are the cause of mouth breathing in their children. In such cases they may be able to do much good by suggesting the importance of attention to any possible obstructions of the character here referred to. Of course the condition is not confined to childhood, but whenever present it can only be rectified by surgical treatment.

The antrum is the seat of a variety of diseases which are by no means readily diagnosed. This cavity is lined with a mucous membrane of the same nature but more delicate than that of the mouth, and is therefore more readily disturbed, and owing to its form and position, its drainage in case of pus formation is more difficult. When inflammation, however slight, has once been set up within, it is ever after in an irritable condition; and when pus finds its way to this almost closed cavity, the work of destruction of its mucous membrane begins, and unless promptly checked the bony tissue adjacent to the diseased part falls a prey to the destructive pus cell.

Among the causes of affections of the antrum, the teeth and their diseases stand first. You can readily understand how an abscessed tooth can light up an immediate inflammation in the antrum when you recall the fact that it is not uncommon for the teeth to extend into the antrum—the impingement varying from the mere penetration of the end of the root to the extent of half of it, with only the mucous membrane intervening. If the pulp of such a tooth becomes putrid, the poisonous influence soon extends to the surrounding tissue. There is no resistance as when the root is enveloped in bone; consequently soreness of the tooth, one of the first symptoms of peridental inflammation, may not be present. Long-continued pulpitis may produce a like inflammation in the antrum. Alveolar abscess should be cured as soon as detected, for obvious reasons.

The common practice of extracting these teeth is unjustifiable. It is true that that procedure often results in a cure of the antral trouble. Why not remove only the putrescent pulp and any necrosed bone, and treat the pathological conditions surrounding the root? Too few physicians place the proper importance on the saving of the teeth, and I regret to say that there are dentists also who do not appreciate the gravity of the loss involved in the wanton sacrifice of a tooth.

Inflammation of the antrum may also arise from a severe "cold in the head"—catarrhal inflammation—when the mucous membrane is generally congested, which condition extends to the antrum; and after the posterior teeth become loose and sore, if the inflammatory state is persistent, the trouble may become chronic. From this condition of the antrum the pulps of the teeth may in turn suffer even to the extent of devitalization, when we have a permanent cause for abscess without external origin. The non-eruption of the teeth is not infrequently the cause of a purulent condition of the antrum, which is difficult to detect, as only in marked cases is there free discharge of pus from the nares, or the formation of a tumor to guide to the point of disturbance. The nervous system is under a constant strain where this purulent condition of the antrum exists. In two cases recently observed, one of the patients had shown marked symptoms of insanity, and the other was insane during three months of the twelve for several years, prior to operation, and her nurse informed me that previous to the clearing of the mind a free discharge of pus from the nose was observable. Frequent and persistent neuralgias can also be attributed to a purulent antrum.

I think it possible that mechanical irritation from the roughened surface of an artificial denture may cause serious antral trouble. The palatal surface of vulcanite plates, especially, is apt to be a source of irritation unless all roughness, such as occurs from bubbles in the plaster, etc., is carefully polished off. A case recently presented in which the plate was rough from this cause, and it seems reasonable to hold it responsible for a cancerous growth involving the entire space covered by the plate. When constant irritation and congestion of the mucous membrane follows the introduction of an artificial denture, it should be removed and substituted by a material which is non-irritant.—*Dr. G. Lenox Curtis, Union Dental Convention.*

COMPOSITE PHOTOGRAPHS UPON A BLACK BACKGROUND.

THE numerous articles that we have published upon composite photographs taken upon the same plate through the judicious use of black backgrounds have encouraged several of our readers to vie with each other in skill and ingenuity in the taking of interesting pictures. We reproduce herewith two such photographs, which are absolutely perfect. The first (Fig. 1) is due to Mr. E. d'Ersu, a skillful amateur, who, following the instructions given in a preceding article, finds his background in a window or an open door, but who very happily places the screens in the camera itself. "Every window opening upon a relatively dark room," says our correspondent, "every door of a carriage house or slightly lighted barn will offer an adequate black background. And there is no need in the interior of entire darkness, as the contrast with the external light and a rapid exposure in the open air will permit of leaving out of the question, as of no account, the very faint light that enters through the door, and the actinic action of which becomes null, in fact. But, although the darkness of the background is easily obtained by contrast, the same is not the case for the screens, which, interposed between the objective and the model, receive, like the latter, the full light of day. As black as we suppose them, they will reflect the bright light that strikes them, and the only practical means, that which experience has caused us to adopt to the exclusion of the others, is to place the screens in the camera itself. There is nothing easier, moreover, than this maneuver. A blackened piece of cardboard is provided with an aperture nearly corresponding to the place reserved in the definitive picture for the object (head, bust, etc.) that one desires to isolate. This screen is slid into the first fold of the bellows of the camera, that is to say, very close to the sensitized plate, and, at the moment of focusing, the position of the apparatus is so regulated as to make the image of the subject appear through the aperture in the screen, and in the proper position. This process is the most rapid, and it is especially the surest; no reflection is any longer possible, and the preservation of the plate is absolute. But what is no less advantageous is the sharpness of the outlines, which permits of the most delicate junctions. As such sharpness is inversely proportional to the distance that separates the screen from the sensitized plate, an interval of three or four centimeters suffices in practice to obtain the desired result. This may be judged of by the accompanying proof (Fig. 1), in which the frightened guest perceives his head in a dish. It will be remarked that the junction is natural and that it has been effected without any artifice in the dish covered with a napkin."

FIG. 1.—FACSIMILE OF A COMPOSITE PHOTOGRAPH TAKEN BY MR. D'ERSU.

FIG. 2.—FACSIMILE OF A COMPOSITE PHOTOGRAPH TAKEN BY MR. LABADIE.

The second photograph that we reproduce (Fig. 2) is no less of a success than the first. It was sent to us by Consul F. A. Labadie, another skillful amateur, from Nogales, Arizona. It represents a little Mexican supporting himself upon a seat affixed to the extremity of a pole. This photograph was taken according to directions furnished by Mr. Guebhard, in an article published in a former number.*

Mr. Labadie has also taken other composite photographs, in which the black background consisted of black cloth, and in which no screen was used. One of them represents a table at which are seated three companions, which are all one and the same person photographed three times at three different places on the same plate. As the table and its service were absolutely immovable, they were photographed three times without inconvenience, the images being exactly superposed. The effect obtained is remarkably good. There is here a rich mine of ingenious recreations to be worked by the amateur photographer.—*La Nature.*

THE FESTIVAL OF THE WHEELMEN SOCIETIES OF SAXONY AT LEIPSIC.

THE wheelmen societies of Saxony, representing the better class of the sporting world, came before the public for the first time on the 6th of March, when they held their festival in Albert Hall of the Crystal Palace, in Leipsic. The principal features of the programme were the contest for the championship of Europe for riding on the high bicycle, the championship of Germany for fancy riding on the low bicycle, and the championship of the world for fancy riding on the high bicycle; and besides these contests there was an exhibition of various kinds of riding, as riding in lines on the high wheel, riding in lines on the low wheel, riding in groups of twos and threes, and riding while standing.

The contest for the championship of the world for fancy riding on the high wheel brought four competitors—Gustav Marschner, A. Gouget, P. Kenney and Arthur Streubel—into the arena. Gustav Marschner was the victor, and was rewarded with the title of champion of the world, and an unusually large and valuable medal. A. Gouget received the second prize. In this competition many surprising feats were performed.

Gustav Marschner is one of the best known fancy riders of the present time. Within a few years he has attained his present standing and made himself perfect master of the unicycle and bicycle. He was born November 7, 1864, at Lobau, i. S., and became a mechanic, working on cycles. He learned to ride and took part in several races. As early as 1889 he excited the wonder of cyclists at the festival of the societies of wheelmen, in Dresden, by the elegance and security with which he manipulated the unicycle and bicycle, and in Hamburg, Mainz, Leipsic, and other cities he maintained his reputation as champion rider, and obtained results which raised him to the first rank among fancy riders. Marschner "works" with per-

*See SUPPLEMENT, No. 818, page 13068.

FESTIVAL OF CYCLISTS IN THE ALBERT HALL OF THE CRYSTAL PALACE, LEIPSIC.

feet naturalness and extraordinary daring. Quiet, reserved, not striving for effect, having a thorough knowledge of his ability, and armed with many systems and methods, his performances before the public are harmoniously rounded up, without any disturbing incidents.

The Frenchman, A. Gouget, was born at Avignon in 1865. He is the son of a mechanic and learned his father's trade. In 1882 he learned to ride the bicycle and later the unicycle, and became so skillful with the latter that he was able to ride on a tight rope without a balancing staff. When Gouget first appeared in public in Paris, in 1887, he won the sympathy of sportsmen, because his feats then, as now, bore the stamp of novelty and daring. Using methods which are essentially different from those employed by the fancy riders in Germany, his work shows more instantaneous inspiration, and he carries it on with a certain fire. In some of his performances the virtuoso is very noticeable, while the sportsman is kept in the background. Gouget balances himself on his bicycle high up on a swaying table and chair in a dangerous position, he rides down steps and over an inclined ladder on a unicycle, and he uses machines which illustrate the idea of a wheel in a ridiculous way, for the wheels of these machines bear much stronger resemblance to crushed and bent barrel hoops than to correct circles. Gouget's performances are very extraordinary and of a kind that is entirely new in Germany. The fact that he had great claims to the championship of the world, and still did not gain it, must be attributed solely to his vivacity and the mishaps caused thereby during several of his maneuvers. —*Illustrirte Zeitung.*

THE QUEEN'S BULL "NEW YEAR'S GIFT"—PURCHASED BY THE EARL OF FEVERSHAM FOR $5,000.

THE QUEEN'S BULL "NEW YEAR'S GIFT."

AT the sale of some of the Queen's pure-bred cattle, from the shorthorn, Hereford, and Devon herds, at the Shaw Farm, Windsor Park, the fine bull "New Year's Gift" was purchased for a thousand guineas ($5,000) by the Earl of Feversham, president of the Royal Agricultural Society. This notable beast, which has been successfully exhibited at several cattle shows, combining, it is said, in his breeding some of the best strains of the shorthorn variety in England, Scotland, and Ireland, might as well have been named the "Union" bull. An American bidder wanted him at the Queen's sale, but stopped $200 short of Lord Feversham's price. —*Illustrated London News.*

SEA OTTERS.

IT is a fact not generally known, even among the residents of the State of Washington, that off the coast along the edge of the Pacific Ocean, and almost in the shadow of the majestic Olympic range of mountains, is found, in numbers now rivaling the product of the Aleutian Islands, the much prized sea otter, an animal which furnishes the most expensive fur known to the commercial world. The sea otter fur requires no dyeing to fit it for use like the seal fur, and in its natural state is worth ten to twenty times the figure that the sealskin sells for. It is not usually made into cloaks or sacques, because too heavy, as well as too expensive, to suit the tastes of many, and it is so rare that the fur is not often seen except as trimmings for garments made of sealskin.

The main source of supply for sea otter skins has always been away up in the Aleutian Islands, nearly to the coast of Siberia. A few years ago as many as 7,000 were taken in a single season, but the catch of the season just closed in that region has only amounted to a mere handful, so ruthless and systematic has been the destruction. When that field is exhausted the only one of any extent remaining will be this little bay on the coast of Washington, where for many years the industry of taking skins has furnished employment to a number of weather-beaten hunters. It is not a little remarkable that on all the western coast line of the United States the only places that the sea otter has survived the deadly persecution of the hunter are along the stretch of the Pacific beach between the mouth of Gray's Harbor and Point Granville, a distance of about thirty-five miles, and on the islands of the Santa Barbara coast. Point Granville, with its bold, picturesque rocks jutting out into the sea, is about midway between Cape Flattery, at the mouth of the Straits of San Juan de Fuca, which form the northwest boundary of the United States, and the mouth of the Columbia River, which marks the line between the States of Washington and Oregon. The Pribylov Islands, where most of the seals and sea otters come from, are away up to the northwest nearly 3,000 miles.

There are no sea otters north of Point Granville to the straits, for I have tramped nearly the whole distance of about seventy-five miles along the coast, and have been unable to secure any account from the scattering settlers of the animal having been seen, and it is quite certain that none has been shot there. South of Gray's Harbor, along the coast, the sea otter is also absent, only appearing below Point Concepcion, on the Southern California coast. As nearly as I can discover there are now no sea otters north along the British Columbia coast from the straits.

It is very interesting to see the manner in which the highly prized sea otters are secured here on the coast of Washington. If it were an easy task to get a sea otter, there would no longer be any of them left in these waters, for they have been hunted here for twenty years by white men and a hundred or more by the Indians. The Indians hunt the sea otter from long, heavy canoes, in which they go through the surf, and cruising along a mile or two, shoot or spear the animal as he lies sleeping in the water with only his head in sight. Owing to his extreme wariness, it is hard to approach and difficult to hit the animal after it is found. It is only after long practice that an Indian, accustomed as he is to the use of the canoe, is able to meet with any success at all, for it takes great skill to shoot or spear a floating object in a choppy sea from an uncertain canoe. Very often a hunter remains out five or six days without result.

It is not, however, the Indians who secure the most sea otters, for there are not many natives left, and the pursuit is a hazardous one. It is the white hunter, or "Boston man," as the Indians call him, who has devised a way of getting the coveted fur without risking his life in a canoe at sea. Along this stretch of beach from Gray's Harbor to Point Granville are seven or eight three-legged towers, that look from a distance like huge skeleton pile drivers, with a rude box at the top of each. These towers are called sea otter derricks, and they are erected as far out toward the breakers as practicable without danger of being washed away. The beach is smooth and so nearly level that at a distance of 1,000 feet from shore the water is only two or three feet deep. From the tops of these derricks the hunters pick off the wary sea otter, and it is not an unusual thing for one to shoot and kill his game at a distance of 1,000 yards. But though these hunters are excellent riflemen and their weapons are the very best, they may shoot a hundred times without killing a single sea otter, so that in addition to being good shots they must possess unusual patience. In spite of the apparent lack of liveliness in the pursuit, the sport is a most attractive one, and the hunter who once gets into it seldom abandons it.

In the locality that I have mentioned these derricks, forming a conspicuous feature of the coast scenery, are scattered from two to four miles apart. Two of these lookouts have been up a long time. One is built in the tops of two tall trees on the bank, and the other is on a rock some distance out, the little cabin on top being reached by a rude ladder built of short pieces of drift wood tied together. Severe storms blow the derricks on the sand down every winter, but they are easily rebuilt, as there are great quantities of driftwood handy and no lack of standing timber within a few rods of the breakers. Usually two hunters build a derrick together and share in its use.

These derricks are forty feet high and at the base are twenty-four feet wide. On one of the poles a rude ladder is built, and the three poles are braced together by cross pieces nailed on at different points. Upon the top or apex is built a box, nearly as high as a man's head, open at the top and partially open at the side toward the sea. The ends of the poles are sawed off and a board is nailed on the top, making a seat for the hunter, who sits in this wind-protected coop and, with his rifle resting on the edge of his box in front of him, waits and watches for the game. He soon learns the habits of the sea otter, and can tell by the wind and the tides and the currents where to look for the first appearance of the stubby little head above the water.

Not one sea otter in a dozen sinks when it is killed by a bullet, and the next flood tide throws the carcass on the beach. When a number of hunters are shooting, each one marks his bullets, so that the owner may know when the animal is found. The hunters have implicit faith in each other, and would not think of taking skins that did not belong to them. The Indians going up and down the beach are employed by some of the hunters to look out for their expected carcasses. If they find the dead animals easily they are allowed a small sum, enough to pay them well for their time and labor. If, for some reason, an animal that has been shot fails to come in when or where it is expected, and a whole day has gone by in fruitless search, then the Indian who finds it is given $10; two days after the Indian gets $30 for bringing it in, and if a week elapses from the time a hunter shoots a sea otter to the time it is found, he gives half its value to the Indian, for he has then nearly despaired of ever seeing it.

A full grown sea otter is from four to five feet long and perhaps a foot or more wide. When a hunter secures one, he loosens the hide from the nose and

head, and without cutting it lengthwise at all, he pulls the skin down over the body, the hide being so elastic that this is not a difficult job. It is then stretched over a smooth board six and one-half feet long, nine inches wide at one end and ten at the other end. Each end of this board is tapered to a point. Another board, exactly the same size, is then inserted, and the skin is stretched a foot or eighteen inches longer than its original length. A third board, half the length of the others, is wedged in and the skin lightly tacked at the ends to hold it in place. If any flesh adheres to the skin it is then cut off, and the hide is cured and dried in this condition. In a few days it is taken off the boards and turned fur side out, when it is ready for market.

The most valuable fur is that of the darkest color. A rich, nearly jet black color fur with long silver hairs scattered through is the most prized of all, and such pelts bring the hunter from $150 to $250. The clear black comes next in value, and the brown is the cheapest of all and brings from $75 to $100. These prices do not indicate the true value of the skins, for the locality is a long distance from the railways, and it is very difficult and expensive to get freight of any kind from this out-of-the-way beach. A skin that the hunter sells for $150 more than doubles in value by the time it goes through several hands and reaches a good market. Mr. McIntyre gives an original theory to account for the sea otters staying here when they have long since disappeared from every other place on the coast. He says that, as near as he can ascertain by a close study of maps and charts, it is here that the Pacific drift current, sweeping northward after coming across the Pacific and striking the coast, meets the Japan current sweeping south. The two currents make a mammoth eddy, in which the sea otters are able to swim against the current all the time without getting out of the feeding grounds. This theory of the currents is strengthened by the testimony of mariners who come out of Gray's Harbor. They sometimes find the current in the ocean going north, and at other times in the opposite direction. This would indicate that the place of meeting of these big mid-ocean streams is near Gray's Harbor. Still another evidence of the existence of the eddy is the fact that the beach between Gray's Harbor and Point Granville catches the driftwood of California and also of Alaska—one way to the south and the other far to the north—while, singularly enough, more vessels have been wrecked on this sandy stretch of beach than on all the rest of the coast of Washington and Oregon.—*San Francisco Chronicle.*

VOLATILE COMPOUNDS CONTAINING NICKEL AND IRON.*

By C. F. TOWNSEND, F.C.S.

THE discovery of nickel and iron carbonyls marks the beginning of a new era in metallurgical chemistry, and the light which their investigation throws on the different methods by which we manufacture iron and steel clears up many mysteries. Certainly nothing more remarkable has occurred in the recent history of chemistry than the discovery of these compounds of the metals nickel and iron with the gas carbon monoxide. Judging from chemical precedent, this combination is almost the last thing one would have expected. In fact, so anomalous did it appear when Mr. Ludwig Mond first brought the nickel compound to the notice of the Chemical Society in the middle of 1890 that, for a time at least, many found it difficult to believe in its possibility. However, there is no doubt about it. Nickel carbonyl $Ni(CO)_4$, a considerable quantity of which was exhibited at a conversazione of the Royal Society held in June last,† is obtained by merely passing carbon monoxide, produced by the incomplete combustion of coke or charcoal, over the finely divided metal, and condensing the resulting vapor in a tube surrounded with ice and salt. Its properties have been very fully investigated by its discoverers, Messrs. Mond, Langer, and Quincke, and also by M. Berthelot, who published his results in a recent number of the *Comptes Rendus.*

It is a liquid of very high refractive power and brilliant appearance, having at 62° F. a relative density of 1·3185. It may be kept under water without change, provided the vessel is completely filled and the water contains no air. It is very volatile, and a sharp detonation is caused by rapidly heating the vapor. A mixture of nickel carbonyl with air takes fire on contact with a very hot body, and sometimes explodes. The explosion of a mixture of the dry vapor and oxygen may be brought about by simple agitation over mercury, and its mere contact with strong sulphuric acid occasions a detonation within a few minutes. It dissolves in alcohol, and more readily in benzene and chloroform; concentrated nitric acid rapidly oxidizes it, but dilute acids and alkalies have no action upon it. The liquid solidifies at 13° F. and boils at 109° F., and the vapor, if lighted, burns with a strongly luminous flame which appears smoky in consequence of the separation of metallic nickel. If the vapor be heated to 338° F., it splits up again into its original constituents, the metal and the gas. Advantage is taken of this circumstance to plate bodies with nickel. In order to accomplish this, it is merely necessary to heat them up to or above the temperature just mentioned, and suspend them in a vessel filled with the gas. The same object can also be attained by treating the goods with nickel carbonyl dissolved in suitable solvents, but in this case the film is not so lustrous. The new process possesses a great advantage over electro-plating, as not only metallic surfaces, but any substance, however intricate in design or fragile in structure, can be coated with a brilliant superstratum of nickel by its means, without the tedium and risk of first covering it with blacklead. Some very beautiful specimens of real flowers plated with gold and silver were exposed for sale at the Frankfort Electrical Exhibition, finding a ready market. The possibilities of this new discovery are more than equally great, there being no limit to its applications. It may be, too, that the film thus produced will be less liable to flake off than that deposited by the electric current. If so, one of the principal drawbacks to nickel plating will be removed.

The liquid nickel carbonyl is highly poisonous, and, if injected subcutaneously, acts very powerfully on the animal system, producing an immediate and remarkably prolonged fall of temperature. It might perhaps be introduced into medical practice as an antipyretic in the treatment of fevers, if it were not for the difficulty of administering it in definite and sufficiently small doses. The carbonic oxide alone is the active agent in causing this effect, the symptoms being those of respiratory poisoning, and the blood of animals killed by it exhibits the same appearances as that of persons suffocated by inhaling the fumes of burning charcoal, viz., the characteristic absorption bands when viewed through the spectroscope. The vapor of nickel carbonyl is as poisonous as the liquid, and is dangerous in air even to the extent of only 0·5 per cent.

Another valuable use to which the discovery of this body will almost certainly be put is the extraction of the metal from its ores. The principal sources of nickel are the copper-colored arsenical mineral NiAs, which the German miners, after working unsuccessfully for years in the hope of obtaining copper, named in derision kupfer nickel (*i. e.*, false copper), and in which the metal was first discovered by Cronstadt in 1751; and speiss, an impure arsenide, formed at the bottom of the melting pots in the manufacture of the bright blue pigment known as smalt, much used by paper stainers, which is made by roasting the ores of the closely-allied metal cobalt with quartz and pearlash. From these the metal nickel is separated by reduction with charcoal at a high temperature. It appears now that it will be sufficient to pass carbon monoxide, obtained from coke or charcoal, over the crushed mineral, and condense the liquid nickel carbonyl in artificially cooled tubes. And by simply heating this product to 358° F. pure nickel will be deposited. The ordinary nickel of commerce only contains about 60 per cent. of the metal, the rest being cobalt, iron, carbon, and various other impurities. Even that sold as chemically pure is nearly always contaminated with cobalt. This last impurity is very difficult to remove, for so closely are these two metals connected in the chemical series that a short time ago it was stated by a German chemist that each consisted of a new element and of a substance which was common to both. Further investigation, however, has not borne out this statement. A mixture of nickel and cobalt can be easily separated by carbonic oxide. The latter metal seems to enjoy a complete immunity from its action, and the volatilization of the nickel leaves every trace of cobalt behind. Its easy preparation in a state of purity will, no doubt, largely assist in extending its usefulness, and very probably lead to the discovery of many new applications, for even a minute trace of a foreign body frequently has a very strong, sometimes paramount influence in determining the physical character of a metal. In illustration of this, one need only cite the curious influence exerted on iron by a small percentage of carbon. Pure iron is a comparatively soft, highly malleable, and ductile metal of a bright silvery luster. When broken it has a crystalline appearance, and is not hardened by being heated and suddenly cooled. The first step above this is wrought iron, containing a trace of carbon; steel comes next with 0·3 to 1·5 per cent.; and above that cast iron, with 3 per cent. or upward. The hardness and brittleness seem to depend mainly on the amount of carbon combined with the metal. Other examples abound, and many might be mentioned. In the case of nickel the impurities do not seem to be alloyed with the metal. Extraordinary changes in character sometimes occur when a true alloy is formed, as witness the exquisite gold-aluminum alloy discovered not long ago by Professor Roberts-Austen. It contains 21·6 per cent. of aluminum, possesses a gorgeous purple color, and is the most brilliant and deeply tinted alloy known.

In their original memoir the authors stated that all attempts to obtain a similar compound with other metals had entirely failed. As they considered it very improbable that nickel should be the only metal forming such a compound, they persevered with the experiments, and finally succeeded in volatilizing distinct quantities of iron in a current of carbon monoxide. The iron used was obtained by chemical means in as finely divided a state as possible, and was then treated with carbonic oxide at a temperature of about 180° F. The issuing gas burned with a yellow flame, and when passed through a heated tube, deposited a metallic mirror on the glass, which answered to all the tests of iron. The quantity produced by this method was, however, very small, and the process exceedingly laborious, for it took no less than six weeks to volatilize about 30 grains of iron, it being necessary to interrupt the operation every five or six hours in order to revivify the finely divided metal. Even under the most favorable conditions the gas never contained more than 0·2 per cent. of the compound. By varying the details, especially as regards the preparation of the iron, a much larger yield was produced. This time the gas was not passed over the metal, but the iron was left in contact with a reservoir filled with carbonic oxide, which it gradually absorbed. After a lapse of twenty-four hours the iron carbonyl was distilled off and condensed in a tube cooled to —4° F. The operation was then repeated day after day, until a sufficient quantity for experimental purposes was secured.

The iron carbonyl thus obtained is a pale yellow viscous liquid of specific gravity 1·4666. It distills without decomposition at 220° F., and solidifies below —6° F. into yellowish needle-shaped crystals. It decomposes slowly on exposure to air, and, like the nickel compound, is completely broken up by heating its vapor to 356°. On the other hand, it is much less active than its analogue, and is not acted on by dilute acid, but is oxidized by strong nitric acid. Alcoholic solutions of alkalies dissolve it readily, forming red colored solutions, which rapidly alter on exposure to air. Its composition was at first thought to be similar to that of nickel *tetra* carbonyl, but it was found on accurate analysis to contain five proportions of carbon monoxide, thus giving a formula of $Fe(CO)_5$. Another solid compound of iron with carbon monoxide having the formula $Fe_2(CO)_7$ has been described by Messrs. Mond and Langer, about which we may hope to hear more soon. Its crystals, when dry, have a metallic luster and resemble flakes of gold.

In the early part of the autumn Sir H. E. Roscoe and Mr. Scudder were making experiments on the application of water gas (which is manufactured by passing steam over red hot coke and contains about 40 per cent. of carbonic oxide) for illuminating purposes, by means of the Farnebjelm system, in which a comb or series of fine rods of magnesia are raised to incandescence by a number of small Bunsen flames. After the water gas had impinged on the comb for some hours, it was observed that a red deposit of oxide of iron was formed on the rods, with the result that the illuminating power was considerably diminished. It was naturally thought at first that the iron came from the particles of dust present in the atmosphere of the steel works where the investigations were being carried out. Further inspection showed, however, that the deposit in question was of a "coralloid" structure, and that, therefore, it could not have been produced by the dust, but was contained in the gas itself. In order to ascertain whether the iron existed in the gaseous state or was carried forward mechanically in the form of fine particles, the gas was filtered through several plugs of cotton wool. No difference whatever was observable, and it was concluded that the gas contained a very minute quantity of volatile compound of iron.

In the course of some other investigations, water gas was compressed in steel cylinders to a pressure of eight atmospheres. On burning it immediately after this operation, no visible alteration in the flame could be detected. But if the compressed gas was allowed to remain in the cylinders for about a month, the flame was highly luminous, and immediately deposited on the Farnebjelm comb a yellowish red coating of oxide of iron. It had been shown by the investigators previously mentioned that compression to the extent of even ten atmospheres did not render the combination more active, so that the increased quantity of the iron compound was simply due to the length of time the gas had been in contact with the metal. The volatile substance was completely broken up on passing the gas through a heated glass tube, and the iron partly adhered to the glass in a deep black mirror and remained partly suspended in the gas itself, blackening cotton wool through which it was filtered. The whole quantity, nevertheless, was exceedingly minute, and only a few drops of turbid liquid condensed on leading it through a tube surrounded with ice and salt. In spite of this, there seems no reason to doubt its identity with the iron pentacarbonyl of Mond and Langer.

It has been found that coal gas also contains iron, derived, in all probability, from the slow action of a small percentage of carbonic oxide on the mains and gas pipes. This accounts for the hitherto unexplained black stain so frequently observed on steatite and other burners. Compressed coal gas is very much used now in the place of hydrogen for the production of lime light, and the discoloration of the lime cylinders is very marked, being, it is almost needless to say, somewhat of a drawback to its employment.

In a January number of the *Comptes Rendus* (cxiv., 3) will be found a most important paper by M. Guntz, dealing with the action of carbon monoxide on iron and manganese. He first refers to the work of Slammer, who found that on passing carbonic oxide over oxide of iron at the temperature of the softening of glass, reduced iron is obtained on the one hand and a considerable quantity of voluminous coke on the other. M. Schutzenberger has since found that pure iron decomposes carbonic oxide with formation of carbonic acid and carbide of iron,

$$2\,CO = C + CO_2.$$

In his own experiments, carbon monoxide was passed over very pure iron, produced by distilling its amalgam *in vacuo* at a low temperature (480° to 540° F.) Toward a red heat, the iron seemed to absorb carbonic oxide, being at the same time blackened by a deposit of carbon, and carbonic acid was also disengaged in small quantity.

The same experiment was repeated with the more energetic metal manganese. Pure manganese, prepared in the same way as the iron, was heated to 750° F. in a glass tube in a current of carbon monoxide. The manganese, at a particular moment, was found to glow at one end; the heat was then withdrawn and the current of gas increased. The metal burned in the gas, and the heat disengaged was sufficient to carry it to a white heat; at the same time the carbon monoxide was totally absorbed, and so rapidly as to produce a partial vacuum in the apparatus.

This absorption of carbonic oxide without production of other gas can be explained in two ways: (1) That they combined to form manganese carbonyl,

$$Mn + 5CO = Mn(CO)_5\ (?);$$

or (2) that the gas was decomposed with oxidation of the metal

$$Mn + CO = MnO + C.$$

This last is the only reaction possible, taking into account the great heat produced, and analysis proves that it is actually the case. Carbide of manganese appears, however, to be formed at the same time in small quantity.

This action of manganese on carbonic oxide allows us to give the theory of what passes in the case of iron; there is at the point of contact with the finely divided iron, decomposition of the carbonic oxide, with formation of oxide of iron and carbon,

$$Fe + CO = FeO + C.$$

The carbon monoxide in excess reacts partially on the iron oxide formed, giving carbonic acid, and this explains the invariable presence of carbonic acid in the gas, and that of oxide of iron in the metallic iron. If the reaction is simple and complete with manganese, it holds, as M. Moissan has shown, that its oxide is irreducible by carbon monoxide, which is not the case with oxide of iron, and, moreover, M. Guntz has verified the fact that manganese burns in carbonic acid with the same facility as it does in carbonic oxide,

$$2\,Mn + CO_2 = 2\,MnO + C.$$

It is to be remarked that at very high temperatures the oxides of iron and manganese heated with carbon give the metal and carbon monoxide, or the inverse reaction to that which passes at 930° F.

By means of these results M. Guntz explains what takes place in the blast furnace, although he does not take into account the part played by iron carbonyl as follows: The spongy iron, encountering carbonic oxide,

* From *Engineering.*

† Dr. Mond's paper as read before the Royal Society will be found in SCIENTIFIC AMERICAN SUPPLEMENT, No. 853.

is oxidized, giving carbon and oxide of iron; this last, in another zone, is reduced by carbon monoxide to form metallic iron and carbonic acid, and finally, in passing through the hottest part of the furnace, the iron, in contact with finely divided carbon, is carbureted with facility.

The chemical world is awaiting the further study of the carbonyl series with the greatest interest. Their existence already gives us a clew to the mysteries of the cementation process, in which bars of iron are embedded in powdered charcoal, and kept at about the melting point of copper (2192° F.) for eight or ten days. The principle of all steel making is the same. Carbon has to be added to soft iron in such a manner as to cause a true chemical combination. As previously mentioned, the maximum limit is 1·5 per cent. If that be exceeded, the tensile strength becomes rapidly reduced, until the brittle character and granular structure of cast iron is assumed. If the metal were melted in contact with the charcoal, it would be impossible to prevent an excess of carbon being taken up, which would separate out into granules or scales of graphite on cooling. In the cementation process the carbon monoxide, formed by the air in the pores of the charcoal, permeates right through the bars, and is decomposed by the metal; the released oxygen then travels back to the charcoal for more carbon, which is again combined with the iron, the carbonic oxide thus acting as a carrier of carbon to and fro in the mass of the metal until the chemical affinity of the iron is saturated, and the whole is converted into nearly uniform steel. This form is known technically as "blister steel," owing to the peculiar appearance caused by the penetration of the gas. These carbonyls play a very important part, too, in both the Siemens and the Bessemer process, especially the latter. In this case steel is made from cast iron. All the carbon and impurities are first burnt out of the molten metal by blowing air through until the sheet of flame which issues from the converter, finishing its cycle of changes from yellow to blue or violet as the carbon monoxide increases, suddenly drops from its cessation; a definite quantity of a highly carbureted iron, in the form of spiegeleisen or ferro-manganese, is then thrown in, which effects the desired carburation.

Attention has been recently directed, both in our own country and in Germany, to some volatile compounds of platinum with chlorine and carbon monoxide, originally described by M. Schutzenberger in 1868. They are formed by the action of chlorine on platinum sponge at 480° F., and are at once broken up by water with deposition of pure platinum, thus forming a possible way of extracting the metal from its ores. If a volatile gold compound, in any respect similar to these or to iron and nickel carbonyls were discovered, as is not at all unlikely, it would revolutionize the mining industry, not merely by simplifying the present methods of working and reducing the cost of production, but by rendering possible the manipulation of pure ores, which, though now valueless on account of the difficulty found in recovering the metal, would then yield a substantial profit.

AN EXAMINATION OF SOME OFFICIAL PREPARATIONS.*

By HENRY TRIMBLE.

IT has been the custom of the author for several years past to have students in the laboratory examine some of the pharmacopœial preparations. Last year this work was directed more especially to the inexpensive galenicals which are usually prepared by the pharmacist, although in the following list there are a few that are exclusively purchased from the manufacturer.

Tincture of Iodine.—Robert T. Ward purchased one-half ounce samples from the retail stores of Philadelphia. The Pharmacopœia requires 8 per cent. of iodine. An assay of the samples showed them to vary from 3·08 to 16·15 per cent. Two were above the standard and 23 below. Nearly one-half contained about 6 per cent. The sample containing 16·15 per cent. was dispensed in a 2 drachm homœopathic vial, without a label, and was wrapped in a circular. It was prepared while the customer waited, by pouring an unknown amount of iodine into the bottle and filling up with alcohol. The price charged was 10 cents.

Diluted Acetic Acid.—Frank Miller procured twenty samples from retail stores in Philadelphia. With two exceptions they responded fairly well to the official tests of purity, but in strength of absolute acid they varied from 1·80 to 16·20 per cent. It may be recalled here that the Pharmacopœia requires 6 per cent. Exactly one-half were below the standard. The average was 6·24 per cent.

Sulphurous Acid.—Clinton E. Main experienced much difficulty in obtaining samples of this preparation. He was in most cases asked if he did not want sulphuric acid. One clerk informed him that sulphurous acid was dispensed only on prescription. After visiting many stores where it was not kept, twenty-seven samples were finally obtained.

An assay of each showed them to vary from 0·001 to 4·02 per cent. of sulphurous acid gas. The official contains 3·5 per cent. of the gas. Twenty-six of these samples were below the standard and two-thirds of them contained less than one per cent.

Tincture of Chloride of Iron.—William A. Clingan assayed 14 samples of this preparation, purchased from retail stores. Eleven of these gave results above the requirements of the Pharmacopœia and three were slightly below.

Water of Ammonia.—John W. Hough examined 20 samples of ammonia water. The results indicate that neither of the official preparations is usually dispensed. Twelve of the samples indicated a strength of about 14 per cent., 5 were no doubt sold as a 10 per cent. solution, and 3 indicated considerable dilution with water; the lowest showed a strength of 4·56 per cent.

Hydrochloric Acid.—Alexander B. Petrie, Jr., purchased 25 samples of this acid in Philadelphia and Camden. In every case "strong muriatic acid" was asked for. Nine of the samples were found to be chemically pure, and 16 were the commercial acid. Only one was dispensed in a glass-stoppered bottle. The percentage strength of absolute hydrochloric acid was found to vary from 20·9 to 37·8. The Pharmacopœia requires 31·9 per cent.

Solution of Chlorinated Soda.—Harry W. Zeamer assayed 25 samples of this preparation purchased in Philadelphia and Camden. He found 3 of these to contain the 2 per cent. of available chlorine required by the Pharmacopœia. One contained no available chlorine, and most of the remainder contained over one per cent. of the active element.

Diluted Nitric Acid.—G. A. Weston examined 25 samples of this preparation and found the percentage strength to vary from 6·27 to 11·72. Two of the samples contained considerable quantities of hydrochloric acid.

Nitric Acid.—Harry C. Mendenhall found in 20 samples of this acid that they varied from 50·00 to 72·20 per cent. Only one specimen was dispensed with a glass stopper. None contained more than traces of impurity.

Solution of Chloride of Iron.—Charles H. Raudenbush found 14 samples to yield the required amount of ferric oxide. Nitric acid was found in the majority and oxychloride in one-half the samples. One other specimen, although labeled solution of chloride of iron, was found to be the tincture.—*Am. Jour. Pharm.*

* Contribution from the Chemical Laboratory of the Philadelphia College of Pharmacy, No. 107.

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TABLE OF CONTENTS.

PAGE

I. CHEMISTRY.—Volatile Compounds Containing Nickel and Iron.—By C. F. TOWNSEND.—One of the most remarkable chemical discoveries of modern times, with its possibilities described. 13605

II. CIVIL ENGINEERING.—A Short History of Bridge Building.—By C. R. MANNERS.—Iron bridges of different periods from early to recent days.—12 illustrations. 13606

III. CYCLING.—The Festival of the Wheelmen Societies of Saxony at Leipsic.—Remarkable feats in fancy wheeling performed as a competition.—1 illustrations. 13607

IV. EDUCATION.—Technical Education.—By Prof. GALBRAITH.—A review of what is wanted in the technical school, with notes on the University of Toronto. 13607

V. ELECTRICITY.—Dynamic Induction at High Potentials and Frequencies.—By ELIHU THOMSON.—Most interesting experiments with potential differences of 500,000 volts.—5 illustrations. 13608

VI. IRRIGATION.—Decker's Siphon Module.—By C. H. HOVEY.—A measuring device for delivering water to irrigating canals.—1 illustration. 13609

VII. MECHANICAL ENGINEERING.—Improved Hydraulic Die Press.—A press for automatically producing cakes of any material desired, producing several thousand per day.—1 illustration. 13605

Laval's Steam Turbine.—The amazingly rapidly revolving mechanism of the steam turbine.—General particulars of its construction and operation. 13610

VIII. MEDICINE AND HYGIENE.—An Examination of Some Officinal Preparations.—By HENRY TRIMBLE.—Impurities found in medical chemicals.—A remarkable revelation. 13606

Medicated Skin Varnishes.—Formula of preparations used for covering the skin. 13611

Troubles from the Teeth.—A suggestive paper of the injuries which may rise from the teeth and their diseases. 13611

IX. METALLURGY.—Aluminum: Its Manufacture and Uses from an Engineering Standpoint.—By ALFRED E. HUNT.—A valuable review of the aluminum industry and the operations of the Pittsburg Reduction Company. 13605

X. MISCELLANEOUS.—Electric Stock Quotations.—Recent quotations for electric stock of all kinds. 13609

The Queen's Bull "New Year's Gift."—A famous thousand guinea short-horned bull.—1 illustration. 13604

XI. NATURAL HISTORY.—Sea Otters.—How the sea otter is hunted on the North Pacific coast. 13604

XII. NAVAL ENGINEERING.—Life Saving Devices.—More ingenious devices for saving life from wrecked vessels.—24 illustrations. 13602

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